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CONSTRUCTION DETAILS OF A MODERN GAS-HOLDER.

The modern gas-holder is a type of steel structure about which there is very little published information. This statement is particularly true of gas-holder construction as represented by American practice. European builders have been somewhat more generous with information of their work, but the material difference in practice abroad and in the United States renders this information of comparatively small value to American readers. It is with particular interest, therefore, that we present, in the accompanying illustrations, details of a gas-holder which is of essentially American design and construction. This structure is one of six that have been built recently in New York City, and that are fairly typical of the best American practice in dimensions and in design and construction.

GENERAL DESCRIPTION.—Structurally, the modern steel gas-holder is comparatively simple. As illustrated here, it consists of a cylindrical steel tank with a steel plate bottom resting on a specially prepared foundation. Within the tank are nested five steel shells, like the slides of a telescope, and the innermost of these shells has a cover or roof of steel plates. These shells constitute the holder proper. The tank is nearly filled with water, and when there is no gas in the holder the shells are all immersed in the tank nearly to their tops. As gas is admitted, the pressure causes first the inmost shell to rise until its bottom edge locks with the top edge of the shell next outside. This shell is in turn raised by the inflowing gas until it locks with the third shell. In the same way the third shell and then the fourth shell are elevated, and the holder expanded to its full capacity. To guide the movements of the shells as they are lifted one after another there is a series of trussed columns arranged circumferentially around the tank and extending upward to a point above the topmost position of the expanded holder. These columns are braced together by circles of girders and by diagonal tie-rods, the whole structure forming what is known as the guide frame. There are, then, in the type of gas-holder under consideration, three principal parts, viz., the tank, the holder proper, and the guide frame.

TANK AND FOUNDATION.—In the gas-holder illustrated here, the tank is 195 ft. in diameter and 39 ft. 3 ins. deep. It holds, when filled to the normal depth, 8,712,200 gallons of water. The foundation had to be designed to carry the filled tank plus the weight of the holder and the guide frame, which make an aggregate load of something over 60,000 tons. To construct the foundation, 4,100 piles were driven, and capped, first with 12 × 12-in. timbers and then by 6 × 12-in. planks laid tight. On this capping there was built a circular brick wall 5 ft. 6 ins. thick and 8 ft. deep, and having an outside diameter of 199 ft. The space within this wall was filled to within 18 ins. of the wall top with gravel, washed and rolled. The remaining depth of 18 ins. was filled with concrete, on which the steel bottom of 5-16-in. plates was constructed. The foundation just described also contains the tunnels for the three gas inlet and outlet pipes. These tunnels are built of concrete on top of the pile capping and embedded in the gravel filling. One of them is shown by the view Fig. 1. Each tunnel provides for a 36-in. pipe.

VIEW SHOWING CONSTRUCTION OF TOP OR CROWN OF INNER HOLDER SHELL OF GAS HOLDER.

The tank proper is entirely of steel plate. The bottom plating is 5-16-in. thick, and the shell plating, of course, increases in thickness from top to bottom. The shell consists of eight courses or "rims," arranged as shown by the diagram, Fig. 2. The accompanying tabular statement gives a schedule of the stresses in the various rims, and also the sections necessary to withstand them. It will be noted that the joints have a very high efficiency, from 90 to 92% of the solid plate. Fig. 3 is a detail of the joint riveting of the second and third rims from the bottom of the tank. The joint construction between the bottom and the shell of the tank is shown by Fig. 4. Referring to Fig. 3, it will be seen that the plates in these rims are, respectively, 1 13-32 ins. and 1¼ ins. thick, and employ, respectively, rivets 1½ ins. and 1⅜ ins. in diameter.

HOLDER.—The gas-holder proper consists of five concentric cylinders of steel plate; the inner cylinder is provided with a top or roof, and a cup, the three next shells with a cup "and grip" and the outer shell with a grip, which lock them together when expanded. When collapsed, as indicated in Fig. 5, the shells rest on landing girders set on the tank bottom radially at intervals around the outer edge. The positions of the shells when the holder is inflated are shown by Fig. 12. The dimensions of the several shells are as are shown in the table at the bottom of this column.

When inflated to the position shown by Fig. 12, the holder has a capacity of 5,000,000 cu. ft. The five telescopic shells are subjected to a maximum gas pressure of 15 ins. water column or 0.542 lb. per sq. in. when fully inflated. This pressure is produced by the weight of the five shells, or, in other words, it requires a pressure of 0.542 lb. per sq. in. area corresponding to the diameter of the fifth or outer lift to raise the holder to its highest position.

The plates required to resist this pressure are light compared with the tank plates previously described. The lightest plates used in the construction of this holder are No. 11 U. S. Gage. They are subjected to a maximum strain of 6,560 lbs. per sq. in. of net section. The seal rings and grips of the various lifts are, however, for practical reasons, constructed much heavier. Each shell is provided with 40 vertical stiffeners, to hold the light shell plates in position when the holder is collapsed and resting on the landing blocks in the tank. They also serve as guides to the rollers attached to the bottom cups of the various lifts. The drawings of Fig. 6 show sections of the shell stiffeners. The light shell plates are riveted together by ⅝-in. and 5-16-in. rivets, driven cold by power riveters.

Turning now to the grip and cup construction, it will be seen from Fig. 7 that these parts are made of 10-in. channels and ⅝-in. plates. This drawing gives a section through the second lift cup and the third lift grip, and shows clearly the entrapped water which furnishes the seal against

Name.	Diameter, ft.	Diameter, ins.	Depth, ft.	Depth, ins.
First or inner lift	182	1	38	0
Second lift	184	7⅛	38	0
Third lift	187	2	38	0
Fourth lift	189	8¼	37	6
Fifth or outer lift	192	8	37	0

the escape of the gas. It also shows the shell stiffeners. The cup, as will be seen, is a simple U-shaped trough, with rollers attached to its bottom at each stiffener. The grip is an inverted trough, the dip sheets of which extend upward far enough to prevent the overflow of the seal water and to furnish an attachment for the

Fig. 1. Tunnel for Inlet and Outlet Pipes in Gasholder Foundation.

brackets carrying the guide rollers or top carriages, which guide the lifts as they ascend and descend, and also transmit the wind pressure to the guide frame. These extensions of the dip sheets also carry a horizontal plating, forming a gallery giving access to the carriages. These galleries are reached by stairs and ladders attached to the guide frame, and leading to suitable landing platforms. The view Fig. 8 shows one of these galleries.

The inner lift has a steel plate top in the form of a spherical segment, with a crown rise of 11 ft. 3 ins., which corresponds to a sphere radius of 375 ft. This segment is made of rather light crown plates, No. 9 U. S. A. Gage, attached to the shell by means of a comparatively heavy circular girder, constructed as shown by the diagram Fig. 9 and the view Fig. 10. This girder has to resist the compression stresses which are produced by the tensional strains acting uniformly over the entire crown. A maximum gas pressure of 0.542 lb. per sq. in. produces in the crown plating a tension of 1,220 lbs. in each strip 1 in. wide. This tension is indicated by T in Fig. 9. The resulting compression, acting on the circular girder in each strip 1 in. wide, is 1,180 lbs., and is indicated by C in Fig. 9. The total compression in a ring of 91 ft. radius is 1,288,560 lbs. In the present instance, the selected cross-section of circular girder or crown curb amounts to 90.4 sq. ins., therefore, the compression per square inch is 14,250 lbs. The plates of the crown sheet proper was subjected to a maximum tension of 11,260 lbs. per sq. in. net section. To prevent the thin crown from sagging when the holder is empty and collapsed, it is supported by a permanent staging or timber framework anchored to the tank bottom. This staging is constructed as shown by the drawings of Fig. 5.

GUIDE FRAME.—The purpose of the guide frame is to furnish lateral support to the holder when it is inflated. It has to take up all strains tending to displace the holder shells laterally, and to convey these stresses to the foundations. The principal stresses are due to wind and to snow loads. In computing the stresses in the guide frame of the holder illustrated, a wind pressure of 26 lbs. per sq. ft. on the projection of the cylindrical surface was assumed. In addition to the wind strains a snow load of 5 lbs. per sq. ft. was assumed distributed over one-half the entire crown. Under the above assumptions the pressure exerted in the horizontal planes of the various guide rollers are as follows:

Top rollers of inner lift	99,700	lbs.
" second "	174,200	"
" third "	176,600	"
" fourth "	177,700	"
" fifth "	177,500	"
Bottom " " "	88,700	"
Total	894,400	lbs.

The distribution of this stress to the guide frame is accomplished by means of the rollers attached to the shells, as previously described. There are two kinds of rollers, viz., radial rollers and tangential rollers, and each of the 20 carriages of each lift has one radial and two tangential rollers. By means of the combination of radial and tangential rollers, the pressure is distributed over three-fourths of all the guide-frame standards under all conditions. In determining the principal stresses in the guide frame, however, only one-half of all the standards, that is, ten of them, were assumed to take all the load. All members of the guide frame were so proportioned that the strains per square inch of net cross-section did not exceed 13,500.

The construction of the guide frame is shown by Figs. 11 to 13. Fig. 11 shows the guide frame with four lifts of the holder collapsed, and gives a clear idea of its general construction. Fig. 12 shows one complete bay in elevation, with all strains and cross-sections indicated, and also a sectional elevation presenting the standards in elevation, and the lifts, tank and foundations all in section. As will be seen, the standards are riveted

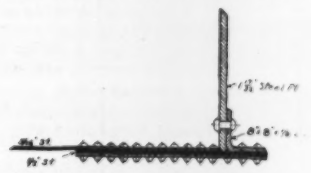


Fig. 4. Detail of Bottom and Shell Connection of Gasholder Tank.

to the tank shell, which conveys the stresses to the foundation. Detail of the standards and of the bracing which connects them are shown by the several drawings of Fig. 13.

METHOD OF CONSTRUCTION.—The construction of the tank and the holder shells of a gasometer is essentially a riveting job. The work begins with the tank bottom, the constituent plates of which are assembled and riveted on a blocking directly over the foundation, and then dropped into place by lowering screws which lower the whole bottom at once. Fig. 14 shows the tank bottom being completed and with the lowering screws in place. The bottom plates are comparatively thin, and the rivets are small, permitting the work to be done by pneumatic hammers. The angle that attaches the bottom to the shell is riveted to the bottom before it is lowered. The assembling and riveting of the tank shell plate follows next, using a special erecting crane, a hydraulic riveting machine for the heavy work, and pneumatic hammers for the lighter work. The view Fig. 15 shows the hydraulic machine at work on the bottom ring of tank shell plates. The riveter is supported by tackle from a "circular crane," which is described further on. The tank shell is assembled one ring at a time by means of bolts, and each ring is riveted complete before the ring above is begun. Rivets $\frac{3}{4}$ in. in diameter and smaller are driven hot by pneumatic hammers, and all others are driven by the hydraulic machine. With the completion of the topmost ring the horizontal gallery plate is riveted on, and on it are mounted brackets carrying a steel strap truck to be used in building the holder shells. The light plates of these are connected by $\frac{3}{8}$-in. and 5-16-in. rivets, which are driven cold by hydro-pneumatic squeezing machines, which are hung from carriages mounted on the track mentioned. The view Fig. 16 shows this track construction and work in progress on the holder shells, and Fig. 17 shows the construction of the top of the inner shell.

The guide frame is erected by means of a circular crane, as shown by the view Fig. 18. The crane consists of a trussed member, one end of which is pivoted at the center of the holder and the other end of which rides on two wheels traveling on a circular track concentric with the holder. For the tank shell work the circular track is laid on the tank bottom just inside the shell; for erecting the portions of the guide frame that are riveted to the tank, the track is carried

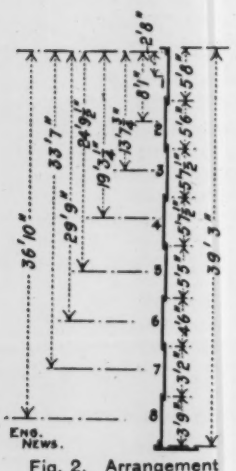


Fig. 2. Arrangement and Dimensions of Ring Courses in Gasholder Tank.

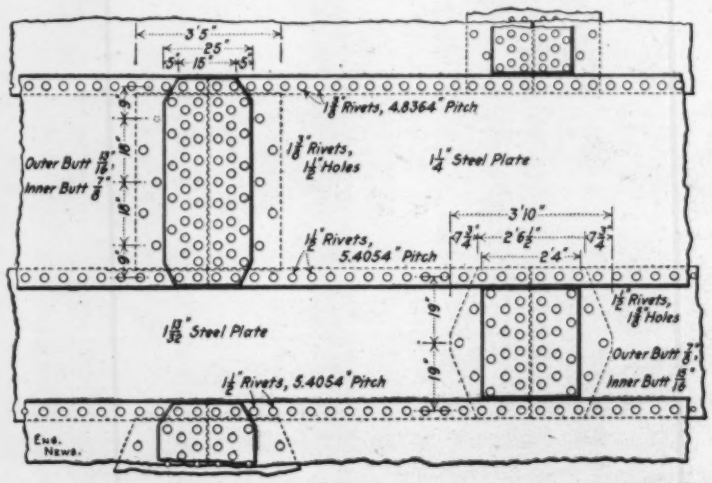


FIG. 3. DETAIL OF RIVETED JOINT IN TOWER RINGS OF GASHOLDER TANK.

STRAIN SHEET FOR 195 FT. × 39¼ FT. TANK FOR FIVE-LIFT GASHOLDER

Number of ring in fig. 2.	Pressure at middle of rim, lbs. per sq. in.	Pressure at place of rupture, lbs.	Required thickness of plate at moment of rupture, inch.	Thickness of plate with a factor of safety of 4.44, inch.	Additional thickness of plate to compensate loss by punching, ⅝ inch.	Total theoretical thickness of plate, inch.	Practical thickness of plate, inch.	Character of riveting, joints.	Size of rivets, dia.	Efficiency of joint. Plating. %	Efficiency of joint. Riveting. %	Fiber strain of net plating at joint, lbs.	Shearing strain in rivets. Single shear, lbs. per sq. in.	Shearing strain in rivets. Double shear, lbs. per sq. in.	Bearing on rivet holes, lbs. per sq. in.
1	1.15	1,346	.0224	.0995	17.9 = .0178	.1173	⅛"	Double Butts	⅝"	84.8	92.7	5,080	.....	5,490	[illegible]
2	3.51	4,107	.0684	.3037	11.1 = .0337	.3374	⅜"	"	⅜"	90.0	141.0	12,470	4,930	9,120	[illegible]
3	5.92	6,926	.1154	.5124	9.53 = .0488	.5612	9/16"	"	⅞"	91.8	109.8	12,800	6,725	12,440	[illegible]
4	8.36	9,781	.1630	.7237	8.93 = .0646	.7883	¾"	"	1"	91.8	95.5	13,185	8,005	14,810	[illegible]
5	10.76	12,589	.2098	.9315	9.05 = .0843	1.0158	1 1/16"	"	1⅛"	91.7	92.5	12,950	8,135	15,050	[illegible]
6	12.91	15,105	.2517	1.1175	9.17 = .1025	1.2200	1¼"	"	1⅜"	91.6	92.7	13,190	8,260	15,280	[illegible]
7	14.57	17,047	.2841	1.2614	9.40 = .1186	1.3800	1 7/16"	"	1⅜"	91.4	91.6	13,215	8,360	15,465	[illegible]
8	15.98	18,697	.3116	1.3835	8.81 = .1219	1.5054	1½"	"	1⅝"	91.9	92.2	13,295	8,395	15,530	[illegible]

NOTE.—Factor of safety for plates and rivets, 4.44. Weight of column of water 12 ins. high and 1 sq. in. in area, is 0.434 lb. Ultimate tensile strength of steel plate, 60,000 lbs. per sq. in. Ultimate resistance of rivets in double shear, 70,300 lbs. per sq. in., and in single shear 38,000 lbs. per sq. in.

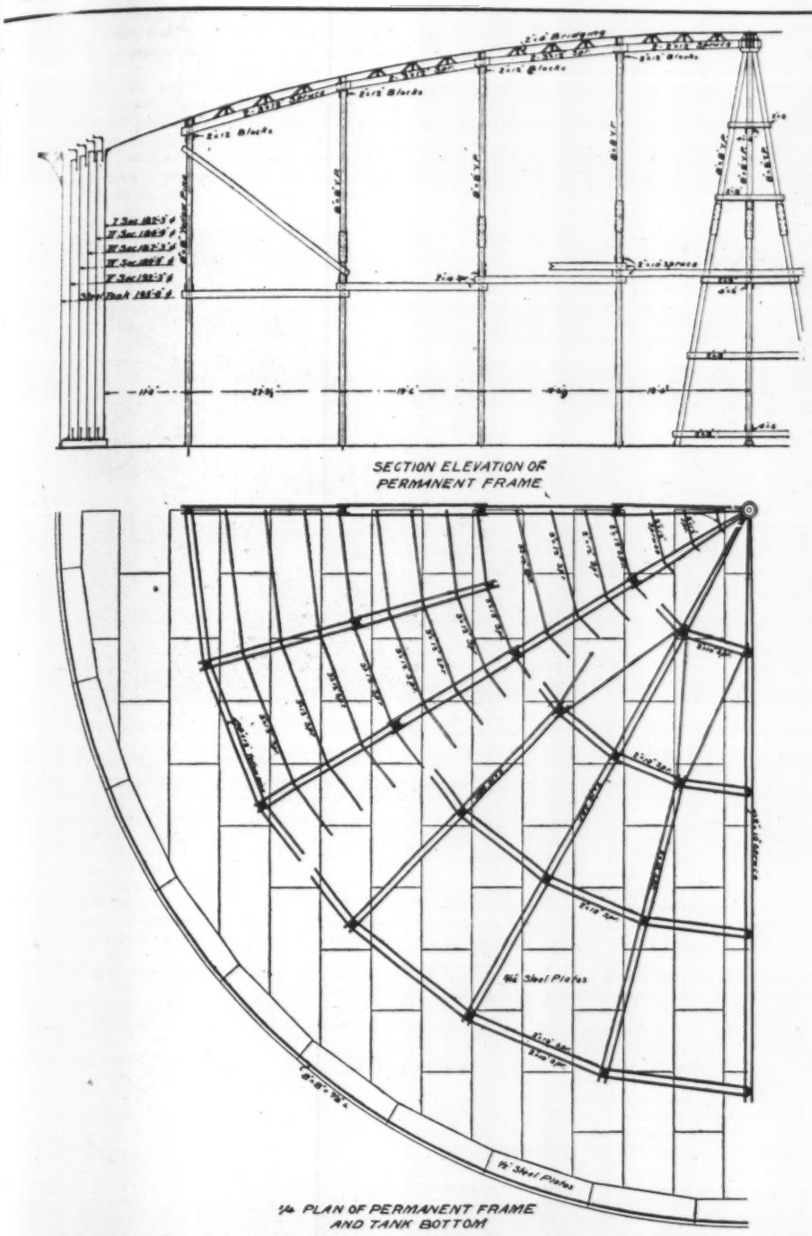


FIG. 5. GENERAL PLANS OF GASHOLDER, SHOWING PERMANENT FRAME OR STAGING.

around the edge of the permanent wooden frame shown in Fig. 5, and for erecting the upper stories of the guide frame the track is placed around the edge of the roof of the inside lift, as shown by Fig. 18. In the last position the crane is kept above the work by inflating the holder with compressed air, thus raising the track story by story as work progresses. The riveting on the guide frame was done by pneumatic hammers.

The gas holder illustrated was designed and built by Bartlett, Hayward & Co., of Baltimore, Md.; Mr. F. J. Mayer, Chief Engineer, and Mr. H. Krekel, Assistant Engineer. We are indebted to the builders for the information from which this description has been prepared.

STEAM TURBINES AS APPLIED TO OCEAN LINERS.*

By J. Harvard Biles, LL. D.†

When the writer agreed to give a paper on this subject, it was hoped that detailed results of the running of the only two complete turbine ocean liners would have been available. The owners and builders of these steamers readily promised such information, but the preliminary difficulties inherent in such a radical departure have taken more time to overcome than some expected, and the results obtained have not been as good as they will be, and are, therefore, not worth publishing. It may, however, be stated that the results completely justify the adoption of the turbine in ocean liners, and that your ex-president, Mr. Parsons, annexation of the whole field of high-speed marine propulsion, from the small type of torpedo boat to the Atlantic greyhound, is now complete. This year the British Admiralty have ordered a set of turbines for a battleship, the latest and largest type, and it is quite possible that we have seen the last of the reciprocating engines for the main propulsion of warships. Such a revolution in the type of machinery has never before been seen; such a great change has certainly never taken place in so short a time.

The first turbine steamer that was built for practical purposes was named the "King Edward." She was begun since our King ascended the throne, early in 1901. Since then a sister vessel, the "Queen Alexandria," has been built for the same service as the "King Edward." Cross-channel steamers "Queen," "Onward," "Invicta," for the Calais route; the "Brighton" and "Dieppe" for the Newhaven route; the "Princess Maud" for the Stranraer route; the "Londonderry" and "Manxman" for the Heysham-Belfast route; and several others have been built and are running successfully all within about four years of the date of the first trip of the "King Edward." British torpedo boat destroyers "Viper," "Cobra" and "Eden," and a third-class cruiser, the "Amethyst," have been built and successfully tried. The United States navy have recently ordered some fast scouts, which are to be fitted with turbines. The French have built a destroyer, the Germans are building at least one warship for turbines, so that the application to all types of high-speed vessels has now reached a practical stage, which will give engineers an opportunity of a complete study of the question of the relative efficiency of the new and the old methods of utilization of steam and propulsion of ships.

Before saying anything about ocean liners, it may be well to shortly state the position of the efficiency of the turbines as far as it has been determined to-day. Mr. James Denny, one of the builders of the "King Edward," gave the result of her working as compared with the paddle steamer which she succeeded. She showed a gain of 20%. Of this 5% was due to the reduced weight of the machinery, and 15% to its increased efficiency. Captain Williamson, one of the owners of the "King Edward," gave the relative coal consumption of this vessel as compared with a paddle steamer of the same speed on service as in the ratio of 1 to 1.32. The paddle engine is not the most efficient propelling agent, and the results are more than usually favorable to the turbine.

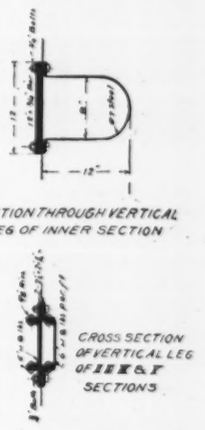


Fig. 6. Sections of Stiffeners for Holder Shells.

The destroyers "Cobra" and "Viper" obtained 36 knots speed against a maximum of 31 knots in the other destroyers of the same dimensions having reciprocating engines. This represents a gain of not less than 25% in production of power. The cross-channel steamer class has given an excellent opportunity for developing the new system of propulsion, because the work is thoroughly practical while the vessels are constantly at work, under observation of the managing staff. They can be readily laid off for the examination and adjustment, which are so much more necessary in the developing stage than at a later one. Two sets of results are available for this class. First, those of the "Queen," the first cross-channel steamer fitted with turbines. Secondly, those for the "Londonderry" and "Manxman," designed by the writer and his partner, Mr. William Gray. The results are given in Table I.

TABLE I.—Comparison of Results of Turbine Steamer "Queen" and three other Steamers on same Route having Reciprocating Engines.

All results are comparative. None are absolute.

	Dimensions.	Coal per H.P.	Per passenger certified to be carried. Coal burnt.	No. of E.R. staff.	Oil used.	Cost of coal E.R. staff.	Speed.
Queen	323 x 43	1.00	1.00	1.00	1.00	1.00	21.00
B.....	324 x 35	1.43	1.74	2.03	2.97	1.8	18.00
C.....	280 x 35	1.25	1.25	1.47	2.47	1.34	18.50
D.....	313 x 36	1.9	2.07	1.73	2.69	2.06	17.50

The first column gives the engineering efficiency, from which it will be seen that the gain over the best of the old type is in ratio of 5 to 4. The commercial and engineering efficiency combined are given in the other columns, and the results are very striking. All the gain may not be due to the turbines, as some may be due to the increased efficiency in passenger carrying in the "Queen," but this cannot be very great. It seems as if comparatively the net gain in commercial efficiency is higher than that in engineering efficiency alone. These

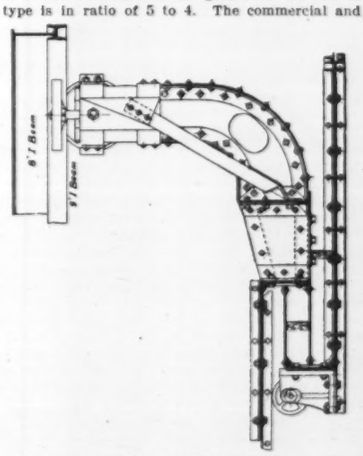


Fig. 7. Details of Guide Rollers, Grip and Cup Between Second and Third Lifts.

*A paper read before the British Association for the Advancement of Science.

†Professor of Naval Architecture, Glasgow University; Vice-President, Institution of Naval Architects.

figures have been supplied by Captain Dixon, the marine superintendent of the S. E. and L. C. D. Railways.

The results of the running of the turbine steamers "Londonderry" and "Manxman" are, from an engineering point of view, equally interesting. These two vessels are of exactly the same form as the vessels "Antrim" and "Donegal," designed at the same time by the writer for the same service, and having reciprocating engines. The latter vessels are identical, and it is thought that they are highly efficient representatives of their class.

though it seems probable that it is represented by a small percentage, about 2%.

As to the comparison between the turbines and the reciprocating engines and propellers combined, their comparative efficiencies are at 20 knots speed, in the following ratios: "Antrim," .97; "Londonderry," 1.0, and "Manxman," 1.11.

Let us turn, however, from the water consumption and speeds on trial to the results in service, which are more interesting commercially than those given above.

engines against 190,000 lb. at 23.6 knots in th[illegible]ine. The difference in speed of 1½ knots at the s[illegible]ficiency of propellers represents about 20% di[illegible] of power, and would expect to find the same di[illegible] in water consumption. This would increase the [illegible] lb. to about 230,000 lb., as against the 215,000 lb. [illegible]ally used in turbine. This shows a gain in favor [illegible]ine of 7%. Here again we have only the combin[illegible]tive efficiency of turbine and propeller, but if the [illegible] propeller is inefficient, it is a necessity of the tur[illegible] and

FIG. 8. VIEW SHOWING GALLERY GIVING ACCESS TO GUIDE ROLLERS.

FIG. 10. VIEW SHOWING CROWN CURB UNDER CONSTRUCTION.

The two former differ only in the matter of turbines. The "Londonderry" has turbine power sufficient to obtain the same speed as the vessels with reciprocating engines. The weight of machinery is less, and the saving in the weight reduces the displacement and the resistance of the vessel, so that the power for the desired speed is less. This advantage to the turbine shows in its first cost, as well as in the cost of running, and it leaves the comparison with the reciprocating engine as one which includes in favor of the turbine the incidental advantage due to its light weight. One of the savings in weight in the "Londonderry" was in the boilers, which, though of the same size and number as the other vessels, had a reduced pressure of 150 lbs., stead of 200 lbs. In the case of the other turbine vessel, the "Manxman," the same saving in weight was not made, but a more powerful turbine was put in, and the boiler pressure was not reduced as in the "Londonderry." By this arrangement the greatest power which the boilers could give was obtained, regardless of the weight of the turbine, instead of, as in the other case, the smallest weight for a given power. The net result was a maximum gain in speed of three-quarters of a knot, which, if the efficiency of the other two ships were the same, is the equivalent of a gain of 14% of power when the extra resistance due to the extra weight is allowed for.

Fig. 9. Diagram of Inner Holder Shell and Top Connection, or Crown Curb.

It is difficult to determine how much of this gain is due to the turbines, as the propellers were different in the three ships, and probably had different efficiencies. But from the result of steam consumption observations, it appears that at about the maximum speed of 22 knots of the "Londonderry," the slower vessel, the extra power required was more, while the resistance was less, the net difference in efficiency of turbine and propeller being at least 12% in favor of the "Manxman," the faster vessel. If this gain in efficiency were maintained throughout to the full development of "Manxman's" power, there would only be a net increase of power developed in the turbine of less than 2%. It is difficult to say whether the efficiency would or would not be maintained, and so one is left in doubt as to the relative efficiency of the larger turbines with the higher pressure,

It is difficult to eliminate effects of weather, tide, loading of vessels, and the other matters which affect results on service, but a fair average can be obtained if sufficient observations are taken. The method of comparison adopted is to find from the logs all the voyages in which two chosen ships were running on the same night in opposite directions. Omitting from these all cases in which full speed was not maintained in the open sea, for all the run the results shown in Table II. were obtained.

This method of measuring efficiency by the ratio of the square of the speed to the coal consumed assumes that resistance varies as the square of the speed. If the actual water consumption curves be used, the results at the same speed give an average advantage of the "Manxman" over the two reciprocating engine vessels of 8.9%.

It will be seen that the advantage of the "Londonderry" over the "Antrim" on trial was 3%, but that it changed to a disadvantage of 1.3% on service, making the "Antrim" 4.3% better on service, relatively to the "Londonderry," than she was on trial. The similar figures, "Antrim" and "Manxman," show the latter 14% better on trial, but 8.2% on service, a gain for the "Antrim" of 5.8% as between trial and service conditions.

It is seen that the efficiency on service seems to be less marked in the turbine than it is on trial. It may be that with the increase of resistance due to sea wind and foul bottom the turbine propellers are less efficient relatively as they are so small, but it is reported that in bad weather there is less racing in the turbines. Until we have careful water consumption tests systematically carried out, this point will remain doubtful.

It seems certain, however, that 8 or 9% of gain may be relied upon if the turbines are as efficient as those of the "Manxman."

The weight of the "Manxman's" machinery, and the part of the hull lightened, turned out to be 115 tons less than the "Antrim," a saving of 15% in the total weight of engines and boilers, etc.

It may be remarked that the reciprocating machinery referred to is the very best of its kind, and is of the highest attainable efficiency for this class of machinery.

With reference to the warship machinery, the Admiralty built four vessels of the same form and dimensions. Into one they put turbines and in the three others reciprocating engines. The vessels' dimensions are 360 ft. by 40 ft. by 14 ft. 6 in. draught; displacement, 3,000 tons. The reciprocating engines developed 10,000 indicated horse-power, and the vessels attained a speed of 22.1 knots speed. The turbine vessel attained a speed of 23.6 knots. Water consumption trials gave at 22.1 knots 215,000 lb. per hour in the reciprocating

TABLE II.

R—Reciprocating. T—Turbine.	Antrim R.	Londonderry T.	Londonderry T.	Donegal R.	Donegal R.	Manxman T.	Manxman T.	Antrim R.
No. of trips	48	48	42	42	39	39	29	29
Average coal per trip	35.6	35.3	36.9	36.0	33.7	40.2	38.6	38.6
Average speed in knots	19.7	19.5	19.8	19.2	19.3	20.3	20.3	19.5
Speed²	10.9	10.76	10.62	10.24	9.59	10.25	10.67	9.85
Coal consumed per cent. in favor of	1.30	—	3.6	—	—	6.6	8.2	—
		Londonderry				Manxman		
Mean per cent. in favor of turbines		2.4				7.7		

if it is more efficient than the large propeller, it may be taken as an incidental advantage of the turbine. The former is probably the truth.

Four 2,170-ton turbine vessels, of dimensions 275 ft. by 44 ft. by 16.6 ft. have been built, and are running for the British India Company from the Persian Gulf to India, having speeds of 18 knots, which involve about 6,000 HP. A vessel of 2,448 tons, of dimensions 300 ft. by 43 ft. by 25 ft., named the "Loongana," for the Union Company, of New Zealand, having a speed of 20 knots, and about 6,000 HP., on trial has steamed from Scotland to New Zealand, and is there successfully running. These two cases are between cross-Channel steamers and the large ocean liners.

Coming to the question of ocean liners, there are two ships, the "Virginian" and the "Victorian," of the Allan

Fig. 11. General View of Gasholder, Showing Guide Frame.

line, fitted with turbines. The particulars of the first of these vessels are as follows:

Particulars of the Turbine Steamer "Virginian."

Name	Virginian
Owners	The Allan Line Steamship Co., Ltd.
Builders	Alex. Stephens & Sons, Ltd.
Date	1905
Length	320 ft.
Breadth	60 ft.
Depth	41 ft. 2 in.

Maximum load draught	29 ft. 6 in.
Displacement on trial, about	13,000 tons
Speed on trial	19½ knots
Revolutions of propeller, each	285
Engines, 3 steam turbines: High pressure in center; Low-pressure and reversing at sides	
Boilers, Number	9
Diameter	17 ft.
Length	12 ft.
Pressure	180 lb.
Heating surface	30,800 sq. ft.
Grate surface	726 sq. ft.
Tonnage, net	6,844
Tonnage, gross	10,755
Number of first-class passengers	470
second-class "	200
third-class "	950
Number of passengers gained by fitting turbines	60
Weight of machinery saved	400 tons

The mean speed across the Atlantic is 17 knots, and the coal consumption is practically the same as for triple-expansion engines of the most modern type. There is no doubt that when a proper adjustment of form, area and pitch of propeller to the boiler power and the form of the ship has been reached in these ships, the turbine system will prove an advance upon, and, indeed, supersede, the reciprocating engine for vessels of this class. The best results obtained have not yet been so good as the steamers are capable of, and therefore there is no possibility of saying anything more definite as to the efficiency of turbines in ocean liners at present than that they have justified their adoption in such vessels.

The Cunard Company are carrying out an interesting experiment, as, like the Midland Railway Co., they have reciprocating engines and turbines in two exactly similar vessels, the "Caronia" and "Carmania" respectively. The former has attained 19½ knots on trial and 18 knots at sea. They are vessels 678 ft. long over all, 72 ft. beam and 52 ft. depth. Their draught will be at least 32 ft., and at that draught will displace 30,000 tons. They will carry 300 first, 350 second, 1,000 third-class passengers and 1,000 steerage. The engines of the "Caronia" developed 22,000 indicated HP. on trial at 19½ knots.

The "Carmania" has three turbines, one high and two low. She is nearly ready for trial. Her turbines have been made by her builders at Clydebank, and are the largest yet constructed for marine or any other purposes.

Two other vessels for the Cunard Company are building having turbine machinery of the enormous power of 65 000, but few details of these are available for publication. These vessels represent the boldest undertaking in marine engineering that the world has ever seen.

So far no other large lines have followed the bold lead of the Allan and Cunard lines, though at the moment of writing the Morgan line from New York to New Orleans is reported to have commenced a 6,000-ton vessel of 15 knots. There will be at some time not very remote turbine ocean liners on all the routes. To-day it may be said that there is every indication that in the largest installations an economy of power and cost is assured, as it has been in the Channel steamers. There seems little doubt that the turbine will completely displace the reciprocating engines in all moderate and high-speed lines.

SEPTIC TANKS AND DOUBLE CONTACT BEDS AT BURNLEY, ENGLAND.

The sewage works of Burnley, England, are unusually interesting and instructive. They include large detritus tanks, septic tanks and double contact beds. Their notable features are due chiefly to their skillful operation under the supervision of Messrs. G. H. Pickles, Assoc. M. Inst. C. E., Borough Engineer and Surveyor, and Raymond Ross, F. I. C., F. C. S., Public Analyst of Burnley. The sewage works are in two divisions. The larger of these was visited last year by a member of the editorial staff of this journal, under the guidance of Messrs. Ross and Pickles. The results of that visit and a brief historical review of the works, which passed through many changes between their original establishment in 1878 and the time of the adoption of the present scheme, may be found in one of the chapters of "British Sewage Works." Later information on the Burnley works is given in a recently published "Report on Sewage Disposal" by Messrs. Pickles and Ross. Some notes taken from this report are given below.

Burnley is a cotton weaving town (county borough) of about 100,000 inhabitants. It is provided with combined sewers. Most of the houses have sewer connections, there being at the date of the report just mentioned only 588 pail closets, cesspools, etc., in the borough. Of ordinary water closets there are 6,493 ("clean water W. C's.," the report calls them); of slop water closets, 15,610; of troughs, 533 ("equivalent to 2,834 W. C's.").

The rainfall from 1895 to 1904, inclusive, ranged from 47.17 ins. in 1903 to 28.35 in 1904, averaging 38.99 ins. "Storm water overflows," the report states, "have been provided at various points along the whole of the sewage system." The average daily water consumption is about 30 (U. S.) gallons, of which 25.5 (U. S.) gallons is for domestic and remainder for trade use.

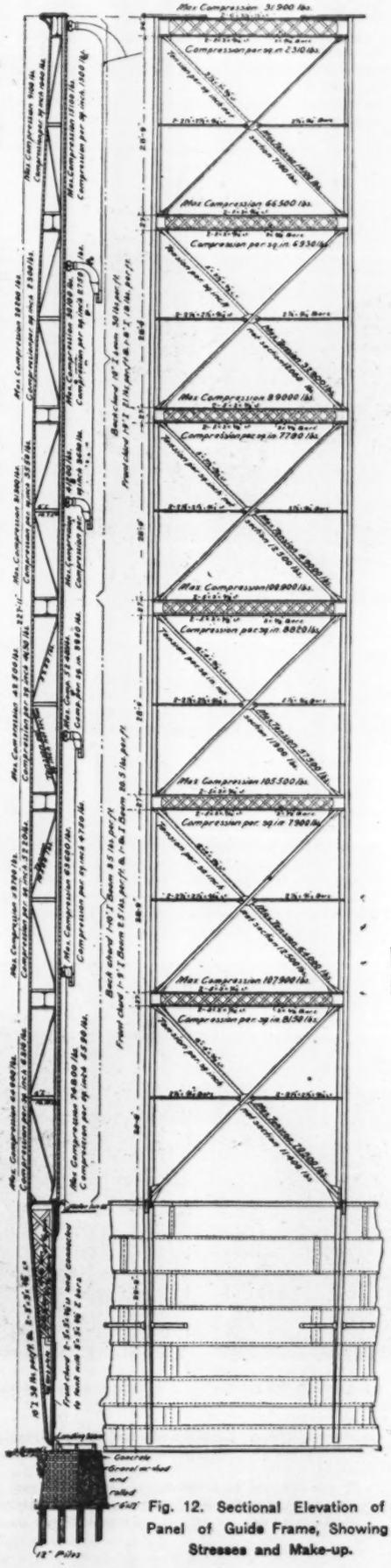


Fig. 12. Sectional Elevation of Panel of Guide Frame, Showing Stresses and Make-up.

The average composition of the crude sewage received at the Duckpits works, based on "a large number of analyses," is (parts per 100,000); albuminoid ammonia, 1.237; free ammonia, 3.74; chlorine, 13.2; oxygen consumed in 4 hours at 27° C., 12.4.

The average daily dry weather flow at the Duckpits works is 2,400,000 (U. S.) gallons. The sewage is passed through three sets of screens, set tandem, with openings of ¾, ½ and ¼-in., respectively. These screens are in duplicate and are provided with revolving rakes for cleaning. Two old tanks, each 50 × 40 ft. × 7¾ ft. deep, are used as detritus tanks. Any excess of storm water is diverted from the overflows of these tanks, instead of passing to the septic tanks. The sludge is removed from each tank and pressed about once in three weeks. Before doing this, the "top water" is pumped off and then 5% of lime, or milk of lime, is added to the sludge. During the last twelve months' working the quantity of sludge removed from the detritus tanks made 810 (long) tons of pressed cake, equal

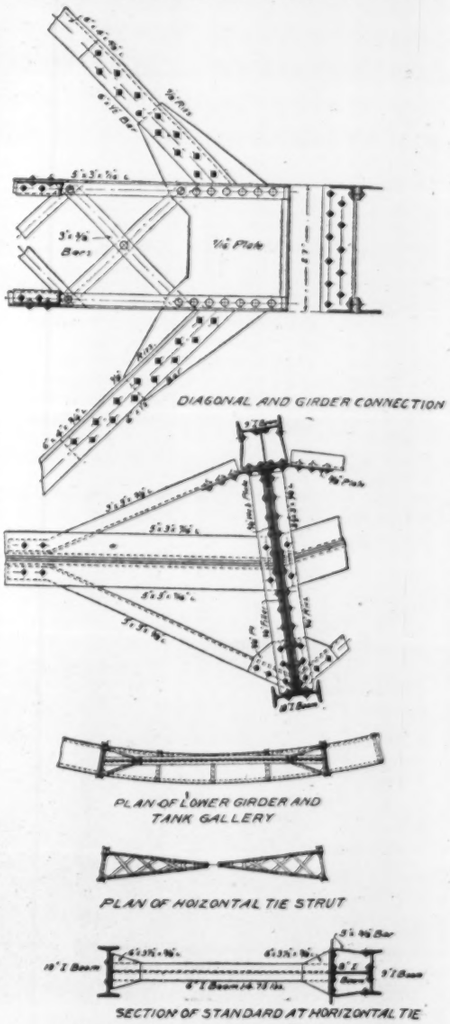

DIAGONAL AND GIRDER CONNECTION
PLAN OF LOWER GIRDER AND TANK GALLERY
PLAN OF HOIZONTAL TIE STRUT
SECTION OF STANDARD AT HORIZONTAL TIE

Fig. 13. Details of Bracing for Guide Frame.

to 2,845 lbs. per (Imp.) 1,000,000 gallons, calculated on the dry weather flow of sewage (about 2,000 lbs. per 1,000,000 (U. S.) gallons).

The septic tanks have a combined capacity equal to about 30 hours' dry weather sewage flow, having been more than doubled in capacity within the past few years. Before the new tanks were built and the large detritus tanks put in

use the sludge had to be removed from the septic tanks about once in six months, and just prior to sludging. A trial showed that when a tank went a year without sludging the suspended matter in its effluent was as high as 35 parts per 100,000. It is thought that sludging once a year will now be sufficient. With the changes already noted, and with the lengthening of the overflow weirs to the full length of the septic tanks, the suspended matter in the tank effluents has been reduced "to as little as 3 to 4 parts per 100,000" during normal and about 9 parts during storm flows.

The septic tank sludge at Burnley is limed and pressed, as is that from the detritus tanks. Since the large detritus tanks were put in use the septic tank sludge has been lighter, more finely divided and more difficult to press than before. The chief difficulty in handling the septic sludge, however, "is caused by the hard, firm scum which forms on the surface." To render this scum more readily limed and pumped, the scum, after removing the "top water," is dosed with sewage, broken up by long wooden rakes, then pumped into whichever one of the detritus tanks that is then empty. Milk of lime is added to the sludge as it enters this tank, thus ensuring a thorough mixing. After about twelve hours' sedimentation the "top water" is drained off, more milk of lime put in, and the whole pumped to the presses, which then handle the sludge without difficulty. The disintegrated sludge cake is sold readily at 10d. (20 cts.) per long ton.

Contrary to general British practice, the contact beds are without concrete bottoms, the 3 ft. of clinker resting on the natural soil. After an experience of nearly seven years it is still believed that the bottom and sides of these beds are impervious to the sewage being treated.

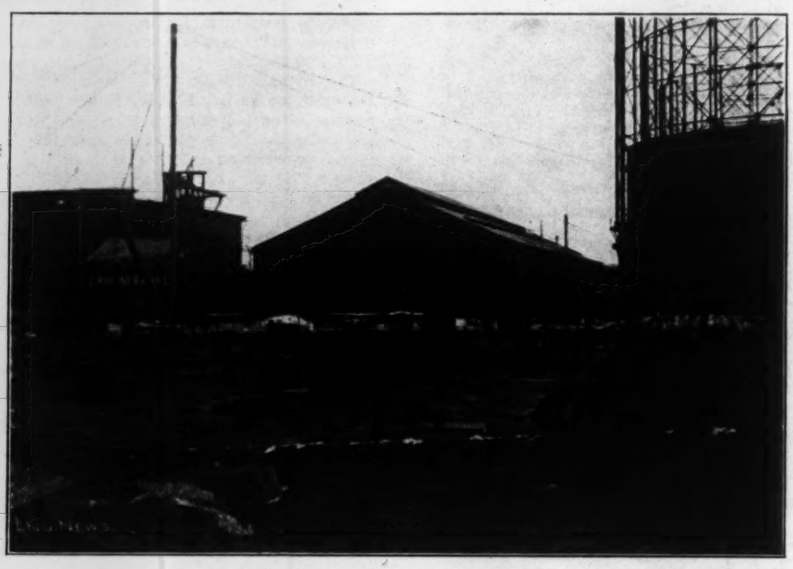


FIG. 14. VIEW OF TANK BOTTOM UNDER CONSTRUCTION, SHOWING LOWERING SCREWS.

For several years the clinker used in the beds was so screened as to provide material ½-in. and more in largest size for the primary beds and ½ to ¼-in. for the secondary beds. Frequent gagings showed that the sewage capacities of the primary beds were considerably reduced after service, some much more than others, the reduction in some cases extending to from 86 to 25 (U. S.) gallons per cu. yd. This was attributed "to the fineness of the material and the unsatisfactory nature of the destructor clinker used in some instances." Trial holes showed that some of the material was holding sewage like a sponge and that in some of the beds the joints were badly clogged with gelatinous material that had formed round them. It is observed in the report that screening does not remove all dust from clinker and that some of the clinker had not been well selected.

It was decided to re-screen and wash the material in primary bed No. 5, the capacity of which had fallen as low as 18.2 (U. S.) gallons per cu. yd.

A portable screening plant, including building to cover it, was provided. The inclined ... screen was 4 × 10 ft., with its upper 1... of sheet iron, its next 4½ ft. of ⅛-in. mesh ... and its lower 4½ ft. of ½-in. mesh wire. T... was placed about 9 ft. above the gr... A chain and bucket elevator, consisting of ... kets, 12 × 5½ ins. × 10 ins. deep, lifted th... ker from a pit supplied with a stream of sep... nk effluent. By this means the clinker was ... ed and screened at the same time, the dust ... all other material and also the water passing ... gh the ⅛-in. mesh into a wooden trough, whe... ost of the waste matter was deposited. The ... sh water was passed onto land and then ont... rm water filter beds. The material dropping t... gh the ½-in. screen was subsequently used fo... ec-ond contact beds and the coarse clinker fr... the open end of the screen went to the first c... act beds. A 10-HP. portable engine was more ... an sufficient for the work. The whole plant, i... ld-ing the engine and shed, cost £280, or $1,3... It can deal with 100 (long) tons in nine hours.

Including the engine driver, 15 men were required to dig the clinker from the beds, wheel it to the screen and replace the washed material. The work cost one shilling or about 25 cts. per cu. yd. for a bed 0.65 acre in extent. This included digging out, washing and replacing the material, propping up the wooden distributing troughs, fuel, and also new material to make good the waste, but it did not include capital charges.

Of the old material taken from this bed, 10% was rejected in washing and screening, 30% was between ⅛ and ¼-in. in size and went to the second contact beds, and 60% was ½-in. or more in size and went to the first contact beds. Of new material, 22% was wasted, 38% was between ⅛ and ½-in., and 40% more than ½-in. in size.

The original sewage distributors on the Burnley contact beds were troughs of wood. For the sake of greater permanency three beds have recently been equipped with perforated glazed earthenware pipe, laid 20 ft. c. to c. on the surface of the beds. A pressure due to a head of 2½ ft. is maintained in these distributors. This system of distribution costs about two-thirds as much as the wood troughs.

No automatic discharging apparatus is used at Burnley. Messrs. Pickles and Ross state in their report that such devices are "very liable to get out of order" and thus require a man to watch them. One attendant at the the works being sufficient, no saving in wages is effected by automatic devices, while the latter cause an increased capital outlay. Moreover, "automatic discharge takes no notice of the condition of the bed," which in the opinion of the authors of the report "is a matter of considerable importance."

In conclusion, Messrs. Ross and Pickles state that in their opinion the sewage disposal problem at Burnley will be solved as soon as the works are completed in accordance with the general plans already outlined.

FIG. 15. VIEW SHOWING MACHINE RIVETING OF LOWER RINGS OF TANK SHELL.

FIG. 16. VIEW SHOWING TRACK FOR RIVETING MACHINES WORKING ON HOLDER SHELLS.

THE MANUFACTURE OF CONCRETE BLOCKS AND THEIR USE IN BUILDING CONSTRUCTION.

(Extracts from Papers Submitted in Engineering News Competition and Not Receiving Prizes.)

I.

Besides the two papers awarded prizes in Engineering News Competition, there were received ten others nearly all of which contained contributions of value to the knowledge of the subject of concrete block manufacture and use. From these ten papers we have selected extracts, and arranged them under descriptive headings for publication. The method of presentation adopted as most nearly fair to all is to give the author's name in each case, and follow it with the extract selected in as nearly as possible the author's own words. When two or more authors have presented the same fact, that author's presentation which seemed to us best, judged by the rules under which the competition was held, has been chosen.

The names and addresses of the authors from whose papers extracts have been taken are as follows: Joseph Babiczky, Guardian Trust Building, Kansas City, Mo.; Geo. H. Crafts, Box 245, Atlanta, Ga.; H. H. Frantz, 3621 West Grand Ave., Des Moines, Ia.; U. G. Hayne, Fort Stevens, Ore.; Noyes F. Palmer, 150 Snediker Ave., Brooklyn, N. Y.; H. H. Rice, 381 South Logan Ave., Denver, Colo.; H. G. Richey, Superintendent, U. S. Public Buildings, Evanston, Wyo.; G. W. Robertson, 105 Walnut St., Marion, O., and G. W. Stevens, 15 Warrenton St., Boston, Mass.

The subjects considered in this article and the remarks under each are as follows:

Location of Plant.

U. G. Hayne.—The points to be considered in establishing a concrete block plant, or factory, are many and various, every locality presenting different difficulties and problems to be settled. The one vital question to be thoroughly looked into and decided before installing a plant in a locality, is: "Will it pay?" In connection with this query must be considered the climatic conditions, and the kind, price and quality of the building materials provided at hand by nature. The facility and cheapness with which good materials can be obtained for making blocks in the locality under consideration should also be closely investigated. It may be that the custom of using a certain building material in a community is so set that in order to get a trade established it will cost considerable in advertising, rustling and time before good results can be obtained. With enough capital this question is easily settled, but it may mean failure to a man of small means before he can get returns.

In years past some one may have so handled concrete work in a locality that a prejudice exists against its use; he having used a poor quality of sand, gravel, or possibly cement; though an even chance poor workmanship. It little matters what the error has been; results will be slower and more expensive until this sentiment is overcome. Therefore the place not so hampered, for the man of small capital, is the best; though a hustler with good goods to make good with, can win out in any community.

A locality that has supported a brick-yard of any size should be able to furnish work for a block plant, though there are many such places where the cost of transporting the sand, gravel and cement will practically prohibit manufacturing blocks at a profit. While, on the other hand, all the materials for block-making may be close at hand, and cheap, in a locality that has no materials for brick-making.

Stone in some places may be cheap enough to

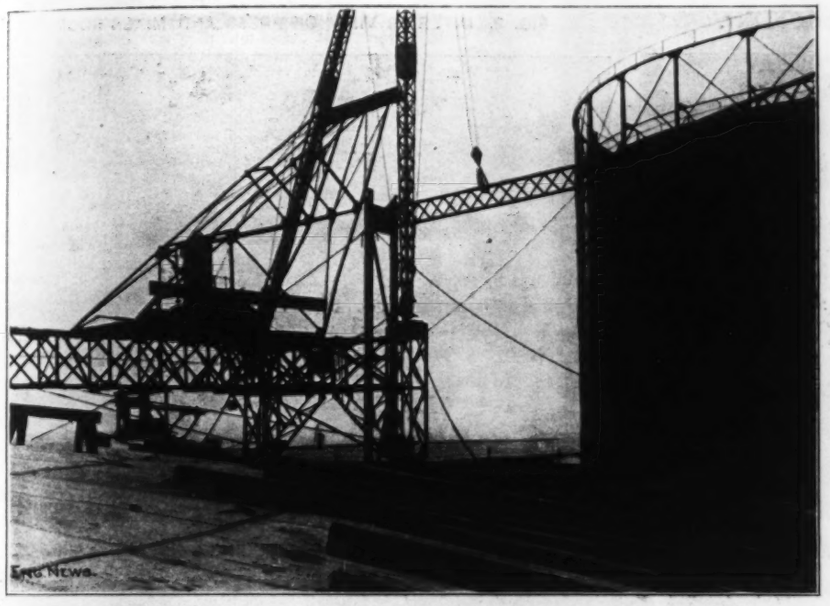


FIG. 19. VIEW SHOWING CIRCULAR CRANE ERECTING GUIDE FRAME.

materially interfere with the use of concrete blocks on account of cost. I think that such cases are rare. No doubt but that brick cuts a more important figure, though I know of instances where the price of brick, a few years ago, could not be touched with concrete for foundations even, including basement walls; where now more than half the work is concrete, and growing in favor. Timber in some localities has to an extent kept out concrete, and will for some years to come; but owing to a material advance in the price of lumber, conditions are changing.

Having decided on the community or town in which to locate, the next item to be considered is the location of the plant. This should be as nearly as possible so situated that the cost of transportation will be reduced to a minimum. The cartage on the finished block will be, in most instances, more for the same distances than that of the raw materials. So a location central for the finished product should be looked for, at the same time keeping in mind that, if possible, a location near a railroad siding will be very convenient. On account of receiving cement, and, in many instances, sand and gravel, by rail, the expense account can be kept down, as well as being in a position to make shipments of the finished product, with all cartage cut out. Where water transportation is possible, it should be considered in this connection.

The plant should be located where water under pressure can be cheaply obtained, either from the city mains or a system constructed for the purpose, as water under pressure must be had for sprinkling the blocks and the various uses of the factory.

In many instances an old mill building or warehouse with sufficient ground adjoining for a yard can be utilized much cheaper than constructing a building.

H. G. Richey.—As the location of the plant will be one of the first considerations in starting a concrete block business, the points to be given the most attention are, the market for the finished product and the proximity of the raw materials; and then after the plant is in operation to turn out a finished product equal or a little better than any other like material on the market. Rather make a high-priced good block than a low-priced poor one; for no person will wish to buy a poor block at any price, but generally people will pay a good price if they know they are getting a good block and their money's worth.

A concrete block plant should be so located that the bulk of the materials to be used can be obtained with the least expense possible. As the broken stone or gravel forms the larger quantity of material to be used, the plant should be, if possible, located adjacent to this supply; if this point is on a railroad, it will also save the expense of hauling the cement from the car to the plant. Another advantage of being located on a railroad is, that the finished blocks can then be shipped by rail to other points, and there will be no expense of hauling from the plant to the car.

Design and Arrangement of Plant.

U. G. Hayne.—In parts of the country where the winters are cold, a basement, in which to work the men making blocks for the spring trade, and to keep the crew together, would be a good investment. Should the location selected have a plot of ground that can be secured and converted into a factory, such as will answer the purpose of the block manufacturer, he can use his best judgment in arranging it to suit his requirements.

In case he has to build and his capital is limited, a cheap wood building large enough to hold about four days' work, with a floor of fine sand, and windows so placed as to give a good light about the part of the building where the making of the blocks is done, will be sufficient in size to start with.

As the blocks must be kept from the sun and wind as much as possible for about ten days, the yard can be so arranged as to keep off the wind by fencing, and on sunny days canvas can be spread over the blocks in the yard which have not been stacked out over six days, or, in other words, over those blocks that are being kept wet. For an output of about 1,000 blocks per week a room will be required approximately 30 ft. wide by about 80 ft. long for the machine, mixing-platform, and room for curing the blocks. By stacking and re-handling the blocks once, this room is large enough to double the capacity.

A close-built mixing platform about 12 ft. × 14 ft. should be placed alongside the block machine, which must be in such a position as to make it handy to the materials, preferably close to one side of the building. The sand or gravel can then be shoveled directly onto the platform from the outside. Where a mixer is to be used, the plant can be so arranged that the materials may be placed in the mixer by machinery, or by gravity, thus doing away with practically all shoveling.

When it comes to a factory the size of which it will pay to so arrange that all mixing, tamping, etc., is done by machinery, the party interested in installing it should take sufficient time and money to investigate the subject thoroughly, and know just what he is doing. My object in this article is to give any information I can that may be of use to the man who has to start in a small way at making blocks or not be able to start at all.

In large plants an arrangement of tracks and cars will be very necessary in handling the blocks about the building and yard. Most machine companies have cars and tracks for handling and curing the blocks, and can give the best arrangement of them for handling the output of their respective machines.

The factory should be so piped that the new-made blocks can be easily and cheaply wet down with a spray of water from one or more sprinklers.

The arrangement of the yard, to facilitate the loading of the finished work, for transportation to the place where they are to be used, with roads through it at convenient intervals for driving trucks, should not be forgotten.

FIG. 1. GENERAL VIEW OF CONCRETE BLOCK PLANT.

FIG. 2. INTERIOR VIEW OF PRESS AND MIXER ROOM

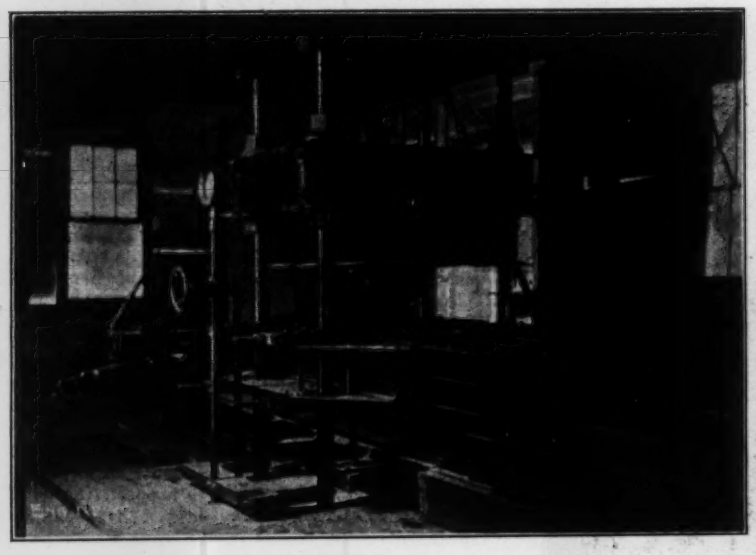


FIG. 3. VIEW OF HYDRAULIC PRESS.

FIG. 4. EXTERIOR VIEW OF CURING SHED AND YARD.

FIG. 5. INTERIOR VIEW OF CURING SHED, SHOWING SLATTED WALLS.

FIG. 6. INTERIOR VIEW OF CURING SHED, SHOWING OVERHEAD TROLLEY, TRUCKS AND MOLDS.

VIEWS OF CONCRETE BLOCK MANUFACTURING PLANT, SUBMITTED BY GEO. H. CRAFTS, ATLANTA, GA.

In most cases it will be best to make the blocks at the factory, and haul them to the place where they are to be used in the building. Yet where a large number are under consideration, at a distance from the factory, it may be profitable to make them on the site of the building to be constructed. A contract or two of this kind would save enough to purchase a tent of sufficient size for the purpose that could be used to good advantage on similar work.

Included in the plant are the shovels, hoes, etc., for mixing; the hose and piping for wetting down the blocks, etc.

Some of the various companies selling machines make a metal bottom board or pallet for making and curing the block on, and which has the advantage of not being liable to check or crack the stone as a wood pallet is apt to do, on account of the wood swelling by absorbing the moisture from the block. Should the wood pallet be kept wet and watched on account of the shrinkage from drying out, they are all right, and much cheaper.

A factory such as spoken of, with the building only high enough to work in, and ready for the machine, should cost from two hundred to five hundred dollars.

G. W. Robertson.—One wishing to engage in the making of blocks, etc., should first select a suitable location after having ascertained probable cost of cement, sand, crushed stone, etc., and finding out probable price he can get for blocks. A location should be selected as handy as possible for the handling of material of all kinds, also for shipment of products, and not too cramped for storage room, as in the handling, re-handling, piling, etc., money is either made or lost. In this business, as in any other, it is the seconds that count. Therefore, it stands you in hand to have everything convenient. The shed or shop for making block, mixing concrete, etc., can be light and airy, while the part of shed where blocks are placed after making should be rather dark, or at least protected from sun and wind till they are fit to move into the yard, this in spite of the claim made by some that blocks can be made either out in the sun, or any old place that may be handy, and given no protection. In arranging the shed or

shop care should be given to have the place for cement as dry as possible.

Joseph Babiczky.—In a large city where a well-organized concrete block company is working successfully, it is perhaps advisable to build a regular factory equipped with the most perfect machinery for turning out high-class and speedy work. Start in always, however, with a tent plant, and when you see that you are successful in the business, consider a permanent plant. In the following table I give the price and size of tents for various daily outputs of concrete blocks:

Dimensions. ft.	Area. sq. ft.	Daily capacity. No. blocks.	Cost of tent.
40 × 61	2,076	300	$150
44 × 65	2,444	400	175
44 × 72	2,752	500	190
48 × 76	3,152	700	215
52½ × 80½	3,633	950	250

After it is seen that it is absolutely necessary to put up a permanent factory, equipped with power mixer, power presses and molds of various sizes and kinds, the tent outfit, with the hand machines, can be used as a "flying factory," which can be packed up in a few hours and shipped to any place outside the city where work may be contracted for. I think that the shipping of concrete blocks is very seldom profitable, on account of high transportation rates, cost of handling and packing, and loss from breakage.

Geo. H. Crafts.—In order to make blocks in the cheapest way, judgment should be used as to the proper location of the plant for business, and the location and design of the buildings and placing of the machinery therein so as to bring the operating expenses down to a minimum. If possible, it is best to locate the plant near a good sand bed, as sand is one of the principal materials used. Then the buildings should be located so that the sand can be gotten into the bins with the least expense, and the bins should be of ample capacity to keep a surplus of dry sand on hand at all times. The boiler and engine, pump, press and mixer, should be so placed that the material can be put through the different processes of proportioning, mixing, pressing and curing with as little handling as possible, and so that the processes can be carried on continuously and with as little interference of one operation with another as is possible. The mixer should be placed so that the materials can be measured and charged into it from the sand bins, and discharged from it in close proximity to the loading platform. The platform should be in line with the press, and the transporting apparatus such that the material can be put through the press and be deposited in the curing shed in the safest and quickest manner. An overhead traveler costs little more than ground tracks, and leaves more ground room for the placing of the blocks. The curing shed should be large enough to hold a week's product of blocks, and should have a sprinkling apparatus throughout the length and breadth of it, so that all the blocks can be kept wet at all times. It is advisable to have the sides of the building closed in so as to keep the sun from shining on the blocks and the wind from blowing the spray about too promiscuously.

In order to conduct a plant successfully, it should be fitted up to make not only building blocks, but also window and door sills and lintels, caps and copings, columns, balusters, rails, posts, and all other building forms; also walk tiles and street curbing, etc. All three of the processes of putting into mold can be economically used; the pouring for complicated patterns, as capitals, columns, balusters, etc.; the tamping process for all blocks where only a few in number of a size are required, and the pressure system for the majority of the work where a number of blocks of the same size and pattern are needed.

Attached are photographs (Figs. 1 to 6, inclusive) of a large and successful Artificial Stone Plant. This is located near a thriving city at the junction of two railroads and on a navigable stream. There is an inexhaustible bed of the finest building sand on the property, and immediately adjacent to the buildings. The buildings consist of a two-story frame building, about 20 ft. by 30 ft., with pattern shop above and mixing and pressing room below; connected to this building is a one-story building containing boiler, engine and pump. Adjoining the press room is the curing shed, which is an enclosed frame building, 150 ft. long by 45 ft. wide. The machinery consists of a 15-HP. boiler, 12-HP. engine, Fisher hydraulic press, cubical mixer, Hexagon tile smoother and ventilating fans. There are two lines of overhead tracks in the curing shed, and ground tracks from the mixer through press and to the switch tracks through the yard. There is an artesian well flowing at least 150 gals. per minute within 100 ft. of the curing shed, and pipes throughout the buildings with sprinkling devices. This plant is equipped for manufacturing in the most approved manner anything that can be made out of concrete, with or without reinforcement, and it is managed by men with a thorough knowledge of concrete and its uses, and who keep abreast with the advance knowledge on the subject.

Forms of Blocks.

H. H. Rice.—To one contemplating the manufacture of concrete blocks as a business there is nothing more important than an exhaustive consideration and investigation of the various shapes, sizes and designs in which blocks have been constructed. Such investigations should not stop with the forms now in actual use, but should extend to all possible forms and their combination in finished buildings. Let us begin with the crudest idea in block construction—a solid concrete block. We note that it has all the advantages of natural stone, that it may be molded in any size or form desired, that it is ready for its place in the wall without chisel or hammer, and hence all expense of cutting and dressing is eliminated, that each block fits in its intended place with a consequent saving in time and annoyance in laying, that the blocks are made on the ground where needed, thus making an enormous saving in cost of transportation, that the walls tend to grow in strength for many years while stone tends toward disintegration from the day it is exposed to atmospheric influence, and, lastly, that it sustains an enormous crushing strain.

The next step in block construction is taken in fulfillment of a desire for a hollow wall, and is exemplified in the use of slabs tied by metal strips and leaving an intervening air space, the effect produced being equivalent to two walls with air space between. Though crude in a way, it is scarcely necessary to elaborate on the advantages of such construction. The building is warmer in winter and the saving in consumption of fuel is estimated at 25%. It is more comfortable in summer. It is sanitary and free from vermin. While moisture may penetrate the outer shell, it cannot pass the air space, and hence the interior is dry in all weather and in all climes. Thus furring and lathing are unnecessary, and plaster or other decoration is applied directly to the interior walls. The patent disadvantages of such construction rest in the metal ties, which are subject, on account of moisture penetrating the outer shell, to rust and corrosion, and experience indicates that they readily attract lightning. However, such a house may be seen in the State of Kansas, now well preserved, though built over twenty years ago by its present occupant; the Fine Arts Building of the Lewis and Clark Exposition is of this style of construction.

To provide a wall having the advantages of the air space without the disadvantages mentioned as appertaining to the metal ties, and to secure throughout the wall a uniform, durable and fireproof material, the hollow block was brought forth. Some 17 years has this block now been in use in America, and it may be described as having an outer and an inner face united by transverse sections or webs, and containing intervening air spaces. When laid in the wall these blocks break joints between alternate courses. The hollow spaces form continuous perpendicular flues. By far the greater number of concrete block buildings in the United States are of this type, and it is not difficult to find factories in operation under some one of the many systems producing this style of block. But man is ever alert for improvement, and experience showed a defect in this construction in that moisture would follow the transverse sections or webs through the wall, causing dampness on the interior and necessitating furring and lathing.

With the view of obviating this fault blocks were devised in which no transverse section passed directly from the outer face to the inner one, and while retaining the external form of the blocks last mentioned the interior construction is such that the cross webs are broken by perpendicular or longitudinal sections, the webs in this type of block assuming a staggered, zigzag or S shape. This considerably impedes the passage of moisture and makes it possible to preserve a dry wall to a much greater degree than in the form of block last described.

In the evolution of concrete block construction there next follows the development of various forms of angle blocks, being modifications of the T, U, E, or L shape, which will, by reason of certain characteristics common to all, be considered in this discussion of structural form as a common type. Of these characteristics we may especially note: (1) That no single block or portion thereof extends through the wall; (2) that no single block possesses both an outer and an inner face; (3) that the blocks in laying a single course overlap breaking joints laterally so that in any given course no joint passes through the wall, while the alternate courses break joints perpendicularly, as in types already considered; (4) that the arms or webs of alternate courses overlap from side to side in such a manner as to form an alternating cross bond extending from the inside of the outer face section to the outside of the inner face section; that is to say, the bond extends almost through the wall; (5) each block is held in place by eight other blocks to each of which it is joined by cement mortar; (6) by leaving the interior joints open a quarter of an inch a continuous horizontal air space exists throughout the wall, and we have in effect two walls tied by the overlapping of arms or webs in alternate courses; (7) by a clever interlocking bond a wall may be produced of any desired width, containing not one, but three, five, seven or more air spaces.

As the development of this type is comparatively new, a brief discussion of these seven points may be profitable. The first precludes the passage of moisture by capillary attraction. The second affords greater facility in facing. The third makes a frost-proof wall. The fourth affords the greatest lateral strength of any known masonry construction. The fifth makes a wall almost monolithic. The sixth gives an insulated wall practically fireproof, a non-conductor of heat, a wall dead as to sound and impervious to moisture. The seventh affords a desirable wall for ice houses, refrigerating plants and packing houses, as well as for bridge abutments, piers and retaining walls.

Thus far we have discussed the various forms of blocks for ordinary or main wall construction, but these alone would not build a house. We must have numerous special blocks. As all systems break joints perpendicularly, half blocks must be used in alternate courses to finish at the end of a wall. Corner blocks must be produced with a return of such length as will conform to the general plan and preserve the bond in the wall. Openings for windows and doors must be provided with jamb blocks of different designs according to the character of casings to be used. The above indicate only a few of the absolutely essential forms of blocks which every system must provide before it can make any reasonable claim to patronage. In addition I may mention lintels, sills, caps, coping, belt courses, arch blocks, keystones as essential architectural members fairly coming under our title.

Joseph Babiczky.—The size of blocks is limited by their weight. A block weighing more than 100 lbs. cannot be handled with ease and speed by one man; it is better not to exceed 75 or 80 lbs.

Geo. H. Crafts.—The one-piece block is simpler to lay in the wall and has been the block principally used up to within the last year or so. The two-piece is a lighter block to handle to make the same size face stone, can be made of more compact material and gives a stronger bond in the wall.

Selection of Materials.

The standard ingredients for concrete blocks are Portland cement, natural sand and crushed stone or gravel. Hints on the selection of these materials are found in the following quotations:

CEMENT.

H. H. Robertson.—Manufacturers should make some simple test to determine what brands of cement give the best results as to color when combined with the sand and aggregate it is expected to use. Prefer cement to be shipped in paper bags, as no care has to be expended in preserving bag, there is less loss by cement sifting out, and paper is less easily penetrated by moisture than cloth.

H. H. Rice.—Having selected a certain brand of cement, stick to it; different brands differ in color; furthermore, there is a difference in the way cement works; one's mixture may be ideal with a certain brand, and give much trouble with another brand.

H. G. Richey.—Puzzulan cement should never be used for making concrete blocks, as such blocks fail from cracking and shrinking (at the surface only) in dry air; in damp places this cement is equal to and in some cases better than the best Portland cement. Color is one of the points to be considered in selecting a cement for making concrete blocks, as the various brands dry out in different colors, some being dark and some light in shade. It would be well to keep samples of blocks made from the different cements to show customers the various shades to be obtained.

Geo. H. Crafts.—Various substances having claims to strengthen or accelerate the action of Portland cement are on the market, but they should be used with great caution, as even if they do appear to strengthen the material when first made they may have a deteriorating action.

SAND.

Since nearly all the writers specify clean and sharp sand, this quality will be understood in the following quotations unless exception is recorded.

U. G. Hayne.—Test sand as to fire-resisting quality, when blocks are liable to be subjected to fire.

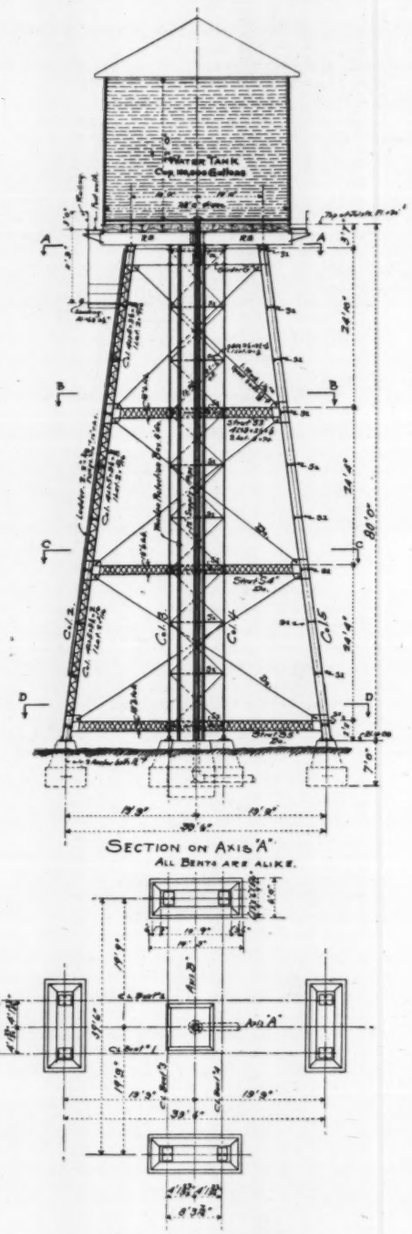
Geo. H. Crafts.—A small proportion of clay makes blocks of a damp mixture stand up better when made, and does not appear to decrease their strength; but too much clay is undoubtedly injurious.

Noyes F. Palmer.—Sand that will not absorb water should be avoided. We had a ton of special sand sent to us; it was the kind used in the manufacture of glass, and sold at $10 per ton. We had difficulty in handling green product made with it, and when the product was cured it looked like "shad roe" when examined with a magnifying glass; the sand grains were all piled on top of each other with voids between. To the naked eye the face looked white and smooth, but the tenacity of the face was lacking.

G. W. Stevens.—Divide sand and gravel into two classes each, viz., fine and coarse. Sand that will go through a sieve having 24 meshes to the inch, call fine sand; of the remainder that portion which will pass a sieve having six meshes to the inch, call coarse sand; of the remainder, that portion which passes a sieve having two meshes to the inch, call fine gravel, and of the remainder, that passing a 1-in. mesh sieve, call coarse gravel. This classification is followed in the proportioning of the mixture. Both sand and gravel should be entirely free from soft stone, or any other material that will absorb water, because such particles when near the surface are liable to freeze and burst out.

H. H. Rice.—Rolling sand between the fingers is an excellent method of determining what is a proper material. In this manner one can determine the relative strength of sand particles, detect the presence or absence of clay, loam or other foreign substance, and observe the presence of "grit." A gritty sand is essential, but loam or clay in any considerable quantity becomes fatal, and necessitates washing. Test the sand not only dry, but ascertain also what effect water will have on it. If wetting causes it to loose somewhat of its "grit" and sharpness, and it shows a tendency to dissolve, or reminds you of the action of sugar, discard it.

H. G. Richey.—Sand for the face should be fine, and that for the body of the block should be coarse, or, better, should range from fine to coarse. The sand for the face, if not perfectly clean, should be washed; that for the body may contain about 5% of clay without detriment to the strength of the block. There must be no clay in the sand used for the face or exposed part of the block.



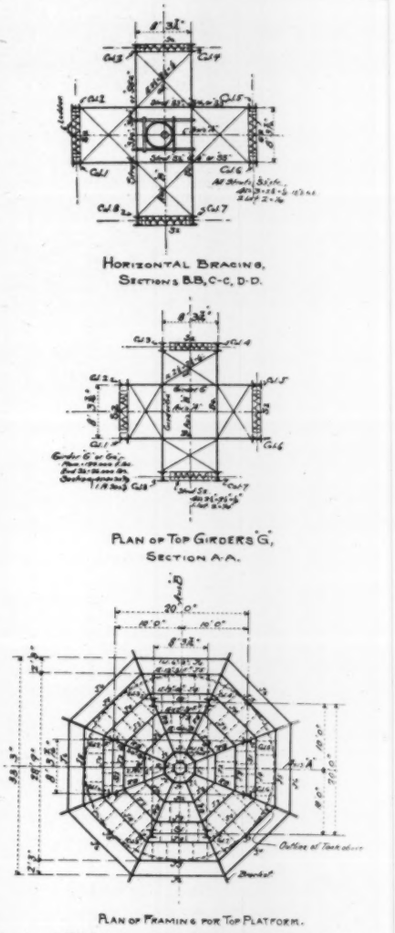


FIG. 1. GENERAL ELEVATION AND SECTIONS OF ELEVATED WATER TANK AND SUPPORTING TOWER, PITTSBURG REDUCTION CO., MASSENA, N. Y.

Joseph Babiczky.—Experiments show that sand containing up to 10% of finely distributed loam makes just as strong and durable concrete as does clean sand. It is to be noted that the loam must be uniformly distributed, and not be in lumps; furthermore, sand containing more than 2% of loam, even finely distributed, must not be used in winter work as freezing destroys the cohesion. Sand must be free from any kind of organic substance such as roots, leaves and straw.

SUBSTITUTES FOR SAND.

Joseph Babiczky.—The following materials can be used in place of sand in making concrete blocks: (1) Fine crushed stone, which can be obtained at no extra expense if the rock is crushed to maximum ¼-in. size, when so much dust will result that the voids in the clean crushed stone are completely filled. This is an ideal material for concrete. (2) In the Southern states, where no sand is obtainable, crushed oyster shells furnish a very good, clean and sharp material, whose only objection is that blocks made from it do not resist fire very well.

GRAVEL AND CRUSHED STONE.

H. G. Richey.—The aggregate may be either broken stone or gravel, whichever is the more convenient and the cheaper; it should be of a size to pass a 1-in. mesh sieve. Some manufacturers of concrete blocks are using sand and gravel combined, as it comes from the pit or river bed; this is poor policy, for the sand and gravel are not uniformly mixed nor in correct proportions; some blocks will have too much sand, and some not enough. When the sand and gravel are found together, they should be first separated by screening, and re-mixed in correct proportions; in this way only can a uniform mixture be obtained.

Joseph Babiczky.—Crushed stone should consist of particles varying in size from pieces passing a ½-in. ring to fine dust. Limestone in no form is permissible, because when the block is heated the limestone is calcined to quicklime, and the blocks collapse, particularly if water is thrown on them.

H. H. Rice.—The choice as between gravel and broken stone must often depend upon the local availability of the two; where both are obtainable with equal facility there is some difference of opinion as to which is preferable. Personally, I favor gravel, as ordinarily possessing greater strength and firmness, although numerous operators are using stone with marked success. Both materials should range in size from "pea" up to as large as can be accommodated in the particular style of mold or machine in use. Remember always that the object is to manufacture stone, and the more of the large sizes contained in the aggregate the more do you take advantage of the help which nature offers in the stone already produced, and the more easy has your art become. Remember again, that you can only make real stone by coating every particle of the aggregate with cement; the smaller the particles of the aggregate the greater is their resulting number, and the greater the amount of cement required to secure the requisite crushing or tensile strength. Hence with a given proportion of cement, the streng

is increased by increased size of the aggregate members. This theory has been well substantiated by exhaustive laboratory tests and by practical experience in general concrete work.

Noyes & Palmer.—It is generally accepted that trap or granite broken into pieces not larger than hen's eggs make the strongest block; that the more stone dust used the fewer voids; that broken stone that averages the size of chestnuts, with fine stone dust included, is easy to handle and manipulate in block manufacture, and makes a neat finish, while too large stone aggregates necessitate slower work.

U. G. Wayne.—For block work no gravel that will not pass a 1½-in. screen, placed at an angle of about 30° with the horizon, should be used. Great care should be taken to have the gravel clean; even though it is worn quite smooth it is all right providing it has the necessary tensile strength and toughness. Broken stone of good texture that will break cubical in form, with the crusher dust left in, will make good blocks.

SUBSTITUTES FOR GRAVEL AND STONE.

Several writers mention the possible substitution of crushed slag, crushed brick, crushed tile and cinders for the usual gravel or broken stone aggregate, but only one gives specific information.

Joseph Babiczky.—Old bricks of hard quality furnish a cheap aggregate for concrete blocks when crushed. Cinders offer many advantages as an aggregate for concrete, but must be used cautiously as they often contain dangerous impurities and particles of unburned coal. They must be carefully washed, screened of ashes, and the coarse particles crushed. Cinder concrete blocks must always have a sand mortar facing about ½ in. thick. It should be noted also that cinder aggregate gives a block weighing about 40% less than blocks of the usual cement, sand, stone mixture.

MIXING WATER.

Few of the papers make any statement as to the quality of the mixing water to be used in making concrete blocks.

H. H. Rice.—Use clean water. Don't spoil your blocks with dirty, impure, muddy water. After performing the physical operation of block-making we feel that we have made stone, while we haven't done anything of the sort; the chemical action of the water upon the cement, causing crystallization of the silicates, is the real process of stone-making. We want the most perfect chemical action obtainable; therefore, use the best water obtainable.

A NOVEL STEEL TOWER AND CONCRETE PLATFORM FOR A WOOD STAVE WATER TANK.

By Charles Worthington,* M. Am. Soc. C. E.

A steel water tank tower with a concrete platform and novel features in framing believed to be advantageous and economical, is described in the following.

This structure, built in 1903, was designed by the writer for the Pittsburg Reduction Co. (Mr. E. S. Fickes, M. Am. Soc. C. E., Chief Engineer) for its works at Massena, N. Y., and consists of two distinct parts: a wooden storage tank, 28 ft. in diameter and 22 ft. high, holding some 100,000 gallons of water, and the steel supporting tower, 80 ft. high to the platform which carries the wooden tank.

The tank is of cypress, with round iron hoops, of a type manufactured in standard sizes by a number of firms throughout the country, and was preferred by the owners to one of steel on account of its smaller first cost, the greater protection afforded against freezing, and the greater tendency of the latter to deteriorate in time by rusting of its interior surface.

The wooden tank being then a fixed quantity in the problem, it is desirable to eliminate as far as possible all wood excepting that pertaining to the tank proper, for the reason that the tank being continually filled with water should be always wet and thus last much longer than any wooden joists below, which would soon be destroyed by alternate wetting and drying and which would be very difficult to renew with the tank in place.

The structure as designed and built is illustrated in the accompanying drawings, Figs. 1 and 2, which show completely all features of the design and require but little explanation. In Fig. 3 is shown a recent photograph of the tower as constructed.

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The tank platform consists of eight 24-in. I-beams placed radially, with I-beam joists extending between them for supporting concrete arches as in ordinary floor construction. The tower columns, eight in number, are located directly under these radial beams and at such positions that the load coming upon each beam will approximately balance it over the top of the column, thus avoiding any considerable shear or bending in these beams at the center of the platform. To provide for any possible bending and shear that might occur, however, on account of discrepancy between the actual and assumed loading, it will be noticed there are two splice plates common to all of the radial beams where they come together, one at the top and one at the bottom, for transmitting bending; and for transmitting shear a vertical plate, bent to a circle, to which all of the beams are connected by angles.

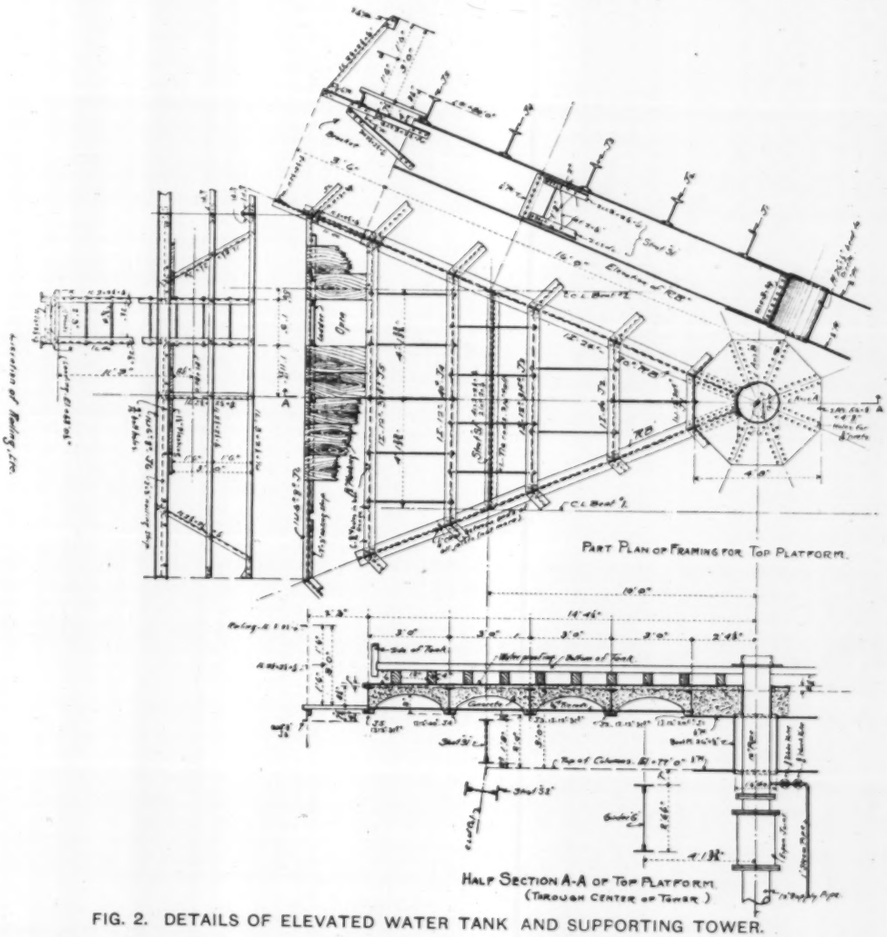

FIG. 2. DETAILS OF ELEVATED WATER TANK AND SUPPORTING TOWER.

The tower proper is made up of two pairs of bents at right angles to each other. The columns are I-shaped, consisting of four angles latticed, and are braced together in pairs. The bracing of each bent consists of diagonal rods and struts as shown. The main struts, S3, S4 and S5, are connected together at their intersections so as to materially shorten their lengths as struts, and are made stiff enough as beams to carry, besides their own weight, the weight of a frost proof box that surrounds the supply pipe extending from the ground up to the bottom of the tank. With the tank filled either pair of bents is sufficient to resist (in the direction of their length) the overturning effect of the wind on the tower. With the tank empty, however, the dead weight of the entire tower and masonry should be effective in resisting this overturning. With this in view the two pairs of bents are connected at their tops by a system of girders, G, which (aided somewhat by the radial beams of the top platform) are sufficiently strong to carry as much of the dead weight of the second pair of bents as may be necessary to resist the overturning effect of the wind, at the same time preventing any possible distortion of the top platform due to same cause. These girders are the only direct connection between the two pairs of bents tending to make them act in unison against the horizontal force of the wind. It is to be noted that these girders are not required to act by virtue of rigid connection to the columns, in the sense of portal bracing, but are intended to act purely as beams. When one pair of bents tends to overturn, pivoting around the base of its leeward columns, it tends to raise its girders, G; but as soon as these begin to move upward, they receive, through the transverse pair of girders, G, the dead load of the other pair of bents. As the girders are required to be continuous across their intersections, splicing against bending and shear becomes necessary. It may be noted also that these girders are utilized as top struts of the lateral bracings in each bent.

A footwalk with handrailing extends around the top platform with a ladder at one side extending down to within 10 ft. of the ground.

The platform arches as constructed are of brick instead of concrete as called for on the plans; the brick construction was found to be a little cheaper in that locality and is equally good. The floor joists are tied together by rods as in regular steel floor construction.

The loads and unit stresses used in the design of this tower were as follows: Dead Load, water 830,000 lbs., tank 25,000 lbs., platform framing, 25,000 lbs., platform concrete, 70,000 lbs., tower framing, 75,000 lbs. Total dead load above foundations, 1,025,000 lbs. A wind load of 40 lbs. per sq. ft. vertical surface was assumed, giving a pressure of 33,600 lbs. on the tank, and a pres-

sure of 330 lbs. per vertical foot of tower. The wind stresses in the legs and bracing were computed on the assumption that all the wind pressure is resisted by the bracing in the two bents parallel to the direction of wind. The allowed stresses were: Tension, 16,000 lbs. per sq. in.; Compression, 16,000 — 60. (l ÷ r) when l is the length of the member in inches and r is its least radius of gyration; shear on rivets, 10,000 and 8,000 lbs. per sq. in., for shop and field rivets respectively;

Fig. 3. View of Tower and Tank from Below.

bearing on rivets, 20,000 and 16,000 lbs. per sq. in. projected surface, for shop and field rivets respectively.

The steel work, consisting of some 50 net tons, was furnished and erected by the McClintic-Marshall Construction Co., of Pittsburg, Pa.

As a proposed improvement over this design as built, the sketch Fig. 4 illustrates an alternate design for the top platform, doing away with the wooden bottom of the tank altogether. The concrete arches are built as before, levelling the concrete off flush with the tops of the I-beam joists. Then is placed and anchored down a section consisting of a 4-in. Z and a 4 × 3-in. angle, riveted together and bent to a true circle as indicated. About this angle are placed the wood staves of the tank, the angle merely taking the place of the

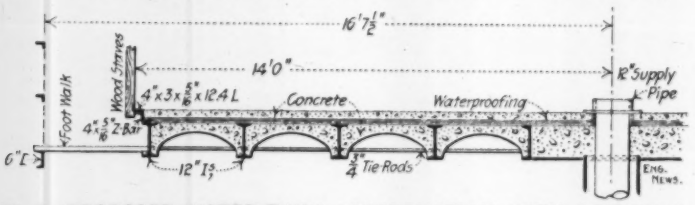

FIG. 4. PROPOSED WATER TANK CONSTRUCTION WITH CONCRETE BOTTOM AND WOODEN SIDES.

circular edge of the wood bottom as usually constructed. After placing an effective layer of waterproofing, say of tar and felt, on top of the concrete arches and joists, a final layer of concrete would complete the tank bottom. This construction would cost about the same as a first-class wood bottom and would be permanent, only the wooden sides of the tank requiring replacement from time to time.

CONVENTION OF THE ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS, PITTSBURG, PA.

The Association of Railway Superintendents of Bridges and Buildings met in its fifteenth annual convention at Pittsburg, Pa., during the week, Oct. 17 to 21. The headquarters tent was pitched at the Monongahela House; here the technical sessions of the convention were held, and here also the supply men made a small exhibition—the first in the history of the association. The attendance at the convention was not particularly great, only about 60 members, or a total of about 150 persons including ladies and guests, but there was a good and consistent representation at the five technical sessions, and a satisfactory amount of interest was exhibited. Unfortunately, the committee reports presented as the result of the past year's work were by no means numerous, and only one or two were adequately comprehensive. As the association works mainly or wholly through committees (having, for instance, ten standing and eight special committees, a total of 18, during the past year), the convention was less fruitful than it might have been.

The time not occupied by technical sessions was used to good advantage in seeing Pittsburg and one or two of the multitude of shops in the district. The new shops of the Pittsburg & Lake Erie R.R. at McKees Rocks, the Bessemer rail mill at the Braddock plant of the U. S. Steel Corporation, the works of the Westinghouse Electric & Mfg. Co. at East Pittsburg, and the Ambridge plant of the American Bridge Co., the largest bridge-building establishment in the world, were visited. In addition a steamer ride up the Monongahela River as far as Braddock, afforded a panoramic view of the industries of a section of the Monongahela River, and of the various kinds and conditions of bridges spanning the river in that section.

The following reviews the technical proceedings of the convention, grouped under the several subjects of committee reports.

CONSTRUCTION AND MAINTENANCE OF DOCKS AND WHARVES.—Mr. H. Rettinghouse, W. C. Ry., Fond du Lac, Wis., as chairman, submitted a report which recognized the division of the subject into tidewater and inland (river and lake), docks, but confined itself to the latter class, or rather to a subdivision, namely Great Lakes docks. By far the most of the Great Lakes vessels dock along river banks, at wharf structures composed essentially of a bulkhead which retains the bank, and a pavement or platform behind the bulkhead. These bulkheads, as well as the dock platforms behind them, are always built of timber, either cribbing or pile-and-timber construction (generally the latter) being used. The report exhibited a sketch of the typical pile-and-timber bulkhead, in which the face-piles, spaced about 4 ft. on centers, are tied back by 1½-in. rods and brace timbers to a longitudinal backing-log lying about 20 ft. back from the face; in very soft ground a second longitudinal, some 40 ft. from the face, is tied to the first one. The report recommends that for immunity from rotting the backing logs be placed at or below water level, a practice not always followed; when the work above water level rots away, it is then possible to restore the dock by building a solid timber or cribbed superstructure from water-level up.

While, with occasional minor exceptions, piers are not used on the Great Lakes for general docking, they are used extensively in the ore-shipping commerce, and in this use form a v… element of the Lake Superior dock f… ore-shipping piers are virtually ele… fitted with spouts for discharging… moored along either side; the hop… from one or more railway tracks ex… the top or deck of the pier. Such p… ally over 1,000 ft., and up to 2,000… high enough to discharge by gra… ports of the largest ore steamers. … storage capacity of from 20,000 to n… tons. They are always of timber … The report of the committee includ… tional views of three representative …

These docks are open frameworks … posts, 50 to 70 ft. high from water-l… deck on which the railway tracks … From the longitudinal center line of the d… inclined floor drops away to either side … of about 45°, until it meets the side … above this line the side is sheathed, … sheathing, with the inclined floor, f… shaped pocket along either side. Th… post framework (suitably braced), th… fitted with spouts at short intervals … side walls, and the railway tracks … compose the whole of the dock.

The report also gives a table of dim… all the Lake Superior ore-shipping piers (the table is reproduced below), and makes the following remarks concerning these structures:

The ore-docks of the Great Lakes are one type of dock which must take a prominent place in the consideration of the subject, having nothing in common with ordinary dock and wharf fronts. Ore-docks are nearly all alike as regards general construction, but this committee endeavored to get specific information from all railroads who own ore-docks as to the cost per lineal foot, cost per M. ft. B. M., and cost per ton of storage capacity. It is to be regretted that replies were received to three out of eight inquiries only, and the largest and latest constructed docks are not represented in the tabulation of cost.

It has been the tendency of late, owing to the steadily rising price of timber, to reduce the amount of timber used in the construction of ore-docks. In one instance, at least, this has proven rather disastrous, one of the latest docks constructed having begun to show decided signs of weakness.

The following is a tabulation of the cost of ore-docks:

Owner	Location	Cost of Dock: Per lin. ft.	Per M. ft. B.M.	Per ton storage capacity
D. & I. R. Ry..	Two Harbors, Minn.	$284.00	$29.00	$8.12
D. M. & N. Ry.	Duluth, Minn.	305.39	27.00	7.00
W. C. Ry.....	Ashland, Wis.	262.00	21.00	6.30

These three docks are closely identical as to general construction. The low cost per lineal foot of the Wisconsin Central dock as compared with the other two is due to the extreme narrowness of the former and, in consequence, less amount of timber per lineal foot.

In regard to maintenance of ore-docks, no figures are at hand. The lining of the pockets, consisting of maple lumber, is about the first part of it to give out; and needs renewal in about six years. Fenders and fender piles, will last on an average ten years, while the main body of dock has been known in some cases to last about twenty years; this last refers to that part of the dock below the pocket-floors, which virtually roof the substructure and keep moisture from it. The superstructure above pocket-floors is very much subject to exposure and wear. Bottoms of end partitions and pocket posts decay very rapidly and demand close attention after from six to eight years.

RECORD OF ORE SHIPPING DOCKS ON THE GREAT LAKES.

Railway.	Location.	Dock No.	No. of Pockets.	Storage Cap'y Tons.	Height: Water to Center of Hinge.	Height: Water to Deck of Dock.	Width Out to Out of Partition Posts.	Length of Spouts.	Length of Dock.	Angle of Pockets.
C. & N. W. Ry....	Escanaba, Mich.	1	184	24,104	28'—10"	48'—6"	37'	21'	1,104'	30°—30°
"	"	3	226	30,284	31'—2"	52'—8"	37'	27'	1,356'	45°
"	"	4	250	32,750	36'—6"	59'—2"	37'	30'	1,500'	45°
"	"	5	232	43,152	28'—6"	53'—3"	37'	21'—8"	1,392'	40°
"	"	6	320	78,000	40'	70'	50'—2"	30'	1,920'	45°
"	Ashland, Wis.	1	234	58,000	40'	70'	50'—2"	30'	1,404'	45°
"	"	2	234	25,000	36'—6"	57'—8"	46'—8"	27'	1,404'	42°
D. & I. R. R. R....	Two Harbors, Minn.	1	202	40,400	35'—5"	59'—6"	49'	27'	1,388'	38°—42°
"	"	2	208	41,600	33'—5"	57'—6"	49'	27'	1,2-0'	38°—42°
"	"	3	170	34,000	40'	66'	49'	27'	1,054'	43°—32°
"	"	4	168	36,960	37'	62'	49'	29'	1,042'	38°—42°
"	"	5	168	33,600	30'	54'—6"	49'	25'	1,042'	38°—42°
D. M. & N. R.R...	Duluth, Minn.	1	384	57,600	30'	53'	49'	27'—9"	2,336'	45°
"	"	2	384	69,120	32'	57'—6"	49'	27'—9"	2,336'	45°
"	"	3	384	80,640	40'—7"	67'—¾"	59'	27'—9"	2,304'	45°
G. N. Ry.....	Superior, Wis.	1	250	40,500	32'—9"	57'	49'	27'—3"	1,525'	45°
"	"	2	350	87,500	40'	72'-8"	62'—8"	32'—4"	2,100'	45°
"	"	3	160	40,000	40'	72'—8"	62'—8"	32'—4"	960'	45°
D. S. S. & A. Ry..	Marquette, Mich.	1	270	27,000	25'	45'	40'	20'—4"	1,700'	90°
"	"	4	200	28,000	27'—9"	47'—3"	36'—8"	21'—1"	1,200'	90°—45°
L. S. & I. Ry.....	"	1	200	36,000	30'—9"	54'	50'	24'—7"	1,232'	38°—42°
W. C. Ry.....	Ashland, Wis.	1	314	48,856	40'	66'—2"	36'—1"	27'	1,908	90°—45°
C. M. & St. P. Ry.	Escanaba, Mich.	1	240	50,400	40'—2¾"	66'—6"	52'	120'—27"	1,500	45°
A. C. & H. R. Ry..	Michipicoten, Ont.	..	12	.....	34'	43'—4"	25'	22'—6"	311'—6	45°

In discussing the report, Mr. R. H. Reid (L. S. & M. S. Ry.), Cleveland, O., reported a piece of difficult foundation work in extending an iron ore receiving dock at Ashtabula, O., a few years ago. The bottom was rock, and the water at the site ranged up to 24 ft. in depth; the structure it was desired to build was of the pile platform type. Vertical holes were drilled in the rock bottom from a scow, and 10-in. extra heavy I-beams were driven down into these holes and then packed round with Portland cement. Another, in discussion, made reference to the excellent paper of S. H. Hyde (Eng. News, May 18, 1905, p. 503 et. seq.), on the practice of the New York City Department of Docks and Ferries in the construction of piers and bulkheads.

A danger menacing these great timber ore-shipping docks was indicated by Mr. Rettinghouse in his account of the destruction by fire of several such docks. In one case lives were lost in the fire because the fire, starting near the outer end, traveled through the mass of timber faster than those on the pier could move toward shore. It appears that since then the expedient of placing full cross-partition walls has been adopted, to serve as a check upon the rapid sweep of flames longitudinally; in addition a complete automatic sprinkler system has been installed. It does not appear that anything in the nature of fire-retardant treatment or paint has been tried.

CONCRETE BUILDING CONSTRUCTION, INCLUDING PLATFORMS.—A very full report was submitted by the committee on this subject, through its chairman, Mr. C. W. Richey (P. R. R.), Allegheny, Pa. The report opens with a concise statement of the scope of the subject as represented in present-day practice:

> The use of concrete in building construction does not appear to have received the attention in railroad work which is its merit. A canvass of the various railroads of the country shows that with few exceptions its use has been confined to retaining wall, bridge pier, arch, and platform construction. A list of questions pertaining to the best practice in concrete building and platform construction was mailed to numerous members of the association and the answers received show that the use of concrete for building purposes on the various railroads has been very limited. The use of concrete for station platforms, however, appears to have the approval of all.

The report gives a well-balanced general discussion of the proper design of concrete buildings for railway use, noting the practical features of general arrangement. For small, unimportant buildings, hollow concrete block walls and a reinforced concrete slab roof are recommended. For larger buildings a monolithic or reinforced concrete construction is appropriate, except that if a reinforced concrete frame, similar to a steel frame, be used, the curtain walls between posts may be made of hollow concrete blocks to save forms. It is stated also that in numerous cases curtain walls have been built by using expanded metal as reinforcement and applying concrete with a trowel to a thickness of two or three inches, using no forms. Numerous points in the actual construction, as well as the features of general design, are touched on by the report. Thus: if walls are built with expansion joints, the joints should extend through the foundations; reinforced concrete walls may be so reinforced as to need no expansion joints, the reinforcement taking up the corresponding stresses; the concrete of girders and column tops should be deposited at the same time; an entire girder should be concreted in one operation; to secure good surface finish, the forms should be smoothly dressed on the inside, joints should be planed down, the cracks should be filled with hard soap or paraffine, and the entire inner surface of the forms should be coated with soft soap; where possible, forms should be removed after 24 hrs., and the concrete surface rubbed with blocks or floats to work out all marks, etc.

This part of the report was supplemented by drawings, photographs and brief descriptions of several concrete block and reinforced concrete buildings, among others a station building of the Wabash Ry., built of blocks, a brick and reinforced-concrete engine house of the Canadian Pacific Ry., and a reinforced-concrete machine shop at McKees Rocks, Pa., this latter having reinforced-concrete crane-girders and roof (arch) trusses. The last-named building was constructed wholly during the winter time; steam heat was used in mixing and in keeping the erected work from freezing until the initial set. The shop is in service at present, and shows no crack or sign of failure.

The subject of station platforms is discussed more precisely in the report; a complete specification for such work is given, as follows:

> The selection of concrete for platforms depends largely on the importance of the station, as its use is not recommended except at terminals and important way stations.
>
> A concrete platform having been decided upon the first step in its construction is the foundation. Excavation for foundation in most cases should be made to a depth of 15 ins. below top of proposed platform height, arranging the bottom so that any accumulation of water under the platform will readily drain off. At locations where an excess of water is expected porous tile drains should be provided as an additional precaution, spaced about 10 ft. apart and arranged to drain into a sewer. A bed of coarse cinder or broken stone should then be laid to a depth of 10 ins. and well wet and tamped. This will bring the surface to within 5 ins. of the grade desired for the platform. The above specification for foundation applies particularly to climates where frost occurs and to locations having a soil of clay formation. The excavation for foundations need not exceed 10 ins. and the foundation course need not be greater than 4 ins. in the warm southern climates not affected by frost and locations having a porous, sandy soil which readily drains off the water.
>
> The concrete base for the platforms to be spread on top of the foundation course and well tamped to a uniform thickness of 4 ins. The materials for the concrete to be cement, sand and gravel or broken stone in the proportions of 1:3:5. The proportions given are those recommended by the majority in their replies. Good results, however, are obtained by the use of a mixture of 1:2:4 or 1:2:5. The substitution of broken stone for gravel is a matter of location and cost. In either case the largest piece to be of a size that will readily pass through a 1-in. ring. The gravel or broken stone to be free of dust, loam or other foreign substance. The sand to be clean and sharp and free of loam. Sand best suited ranges in size from a very fine to a size approaching a fine gravel. For cement most of the American Portlands will give entire satisfaction.
>
> In mixing, the materials in concrete are more thoroughly incorporated by the use of a mechanical mixer, but the yardage is usually so small that its use is not warranted. To make a good mixture by shovel the following method is recommended by the majority: Provide a platform of boards or plank of sufficient size to mix a yard of concrete, this being the maximum amount to mix in each batch. Spread the sand evenly on this platform and then cover with cement in the proper proportion. Mix thoroughly until of a uniform color, then add water necessary to make a thin mortar, and spread again. Add the gravel or broken stone and mix thoroughly until all has a coating of mortar. This will usually require the mixture to be turned four times. Another method of mixing and one which can be recommended by your chairman as quick and efficient, is to spread the gravel or broken stone uniformly over the platform, cover with sand in the desired proportion and then cover with cement spread uniformly in its proper proportion over the sand. All to be thoroughly mixed while dry. Water is now sprinkled over the mixture and the whole mass turned again thoroughly. Water to be added during mixture until concrete is of desired consistency.
>
> After being thoroughly tamped the concrete base should immediately be cut into uniform blocks or squares of a size not exceeding 5 ft. The size selected to be laid out and plainly marked on the confining curb or form and the lines established by straight edge or string. The cuts forming the blocks to be made with a knife bladed tool and must extend clear through the base. The cut formed by the blade to be about ⅜-in. wide and must be filled at once with dry sand. In laying out and making the cuts, the surface of the base to be protected from foot prints by using boards or plank properly raised above the surface.
>
> As each mix of the base is applied and properly cut it must be immediately covered with the top or wearing surface. The hardest and best wearing top surface is formed of one part Portland cement to two parts lime stone, granite or other hard stone screening. The screenings to be fine and contain about 30% of stone dust. The materials for top coat to be spread on the mixing platform one over the other and thoroughly mixed while dry. Water is then added only in such quantity as will make a plastic mass. After being thoroughly mixed the top coat is spread over the base and worked down to a uniform surface and to a thickness of one inch. It should never be tamped but must be worked down hard with "floats." After working with a float a plasterer's trowel is to be used until the surface is worked even and smooth.
>
> With a string or straight edge, using the marks previously made on the curbing or form for use in cutting the base, the surface is to be laid out and cut in squares, directly over the cuts made in the base. Care must be taken that these cuts extend through the top surface into the cuts in the base. The edges of the cuts are to be beveled or rounded with an edging tool. If desired the surface may now be roughened by the use of a dotting roller.
>
> The edges of platforms paralelling the railroad tracks and driveways should be protected by curbing. This curbing may be formed of stone or concrete and may be set before building the platform or built as a part of it. Very good results are obtained from concrete curbing formed in molds and set before work on balance of platform is started. The curbing should be formed in lengths corresponding to the size blocks into which the platform is to be cut. The joints in the curbing and cuts in the platform normal to it should coincide. The concrete base and the top surface of platform should be kept from direct contact with the curbing; joints to be made between the two in a manner similar to the cuts or joints in the platform proper. Edges of the platform abutting the earth or grass plot to be formed by wood form as a curbing is not necessary.
>
> The height of curbing above top of rail and its distance from gage of rail are variable quantities, as no two railroads use the same dimensions.
>
> The pitch of platforms, all agree, should be from ¼-in. to ½-in. in 1 ft. inclined away from the tracks. Cement walks 4 to 6 ft. in width should have the concrete base formed from two to three inches thicker at the center than at the edges. This to prevent the walk from cracking down its center due to the frost raising the edges of the walk.
>
> The following points must be closely observed in the fabrication of a cement platform.
>
> Do not allow any portion of the concrete base or top surface to come in direct contact with the curbing, building, post or other object as expansion and contraction in these will cause cracks in the platform. Provision must be made to separate them with dry sand joints or with tar paper.
>
> See that the roots of trees are removed from under platforms as they cause bad cracks by upheaving the platform.
>
> Do not allow the concrete base to be mixed with an excess of water as the tamping will bring this water to the surface and prevent a bond with the top or wearing surface.
>
> Do not lay a concrete platform in freezing weather unless absolutely necessary. When compelled to lay a platform in freezing weather such precautions as warm water, warm sand and gravel, and a good protective covering will usually insure a good platform; but in general it is bad practice.
>
> Inquiry as to the condition of a cement platform in frosty weather and in snow storms develops a diversity of opinion. Some claim it is not affected while others say it is dangerously slippery. Mr. C. F. Loweth, one of your committee states that the C. M. & St. P. Ry. do not use concrete platforms for the reason that they consider such platforms objectionable in frosty weather on account of their slippery tendency. He also states that they have adopted vitrified paving brick as their standard platform at all stations.
>
> The matter of cost, the most important factor in any platform is a good conclusion for the subject. According to replies received, the cost ranges from 12 to 20 cts. per. sq. ft., including foundations.

Mr. C. H. Biss (New Zealand Government Rys.), Auckland, N. Z., in a communicated discussion stated that he had constructed concrete platforms, 18 ins. high above base of rail, of two courses of concrete blocks, the upper course being made of a rich mixture containing screenings. These platforms are advantageous in permitting easy shifting, and their cost compares favorably with that of platforms made of continuous concrete.

The question of the effect of fire on concrete was raised by Mr. J. H. Cummin (L. I. R. R.), Jamaica, N. Y., who said that when a station building in Long Island City burned down, the concrete (of platforms) was ruined where water struck it, but practically not injured where heat alone affected it. One or two members reported that cinder pits which had been lined with concrete in place of vitrified brick required relining in very short time, the concrete being replaced by brick.

ANCHORS FOR PLOWS AND DERRICKS.—A brief report was presented by the committee, through its chairman, Mr. R. J. Arey (A. T. & S. F. Ry.), Williams, Ariz. The report states that in unloading from flat-cars with a plow, general practice is to set the air brakes, without anchoring the train to the rails, uncouple the locomotive and haul away the plow by the locomotive, using a guide-sheave on curves. Automatic unloaders are also used without anchors. Derrick cars are

in case of heavy lifts, fitted with outriggers on the load side and chained to the rail on the opposite side. Permanent derricks are anchored in rock by guys to ringbolts set in drilled holes, or by weighted platforms; the latter expedient is also often used in earth, or piling may be used. The committee reports no experience with screw and similar anchors. It is recommended that on all derrick anchors where a cable guy is used a fixed sheave should be inserted in the guy line to simplify the work of tightening the guy.

METHODS OF REPAIRING ROOFS.—Mr. J. N. Penwell (L. E. & W. R. R.), Tipton, Ind., reported for this committee. The essential portions of the report are:

SLATE ROOFS.—Remove the broken slate, using the slate ripper to cut the nails. Then nail strips of galvanized iron to the sheathing, allowing them to project about 1-in. below the bottom of the slate. Place new slates, slipping them under the slate next above, and bend the galvanized strip up over the bottom end of the slate to hold it in place, thus avoiding the use of nails where they may be exposed. No. 26 galvanized iron is most suitable for this purpose.

TIN ROOFS.—Repairs on these are generally required on account of neglect to keep the roof properly painted. When the defects are such that they cannot be remedied with cement, the only recourse is to scrape and patch them, covering with a good coat of paint.

COPPER ROOFS.—These are so seldom used by railroads that we have limited experience in this line. Conditions will nearly always govern the process of repair.

PITCH AND GRAVEL ROOFS.—Scrape all the loose gravel in heaps, then inspect the paper thoroughly and make such repairs as are necessary. Cover the new paper with a good coat of pitch, then cover the entire surface with an additional coat, following this with a coat of gravel.

Gravel roofs which seem to be beyond repair can often be made as good as new for half the price of a new roof. No roof is worse neglected than a gravel roof, and we would recommend that as soon as the paper begins to show through the pitch in small spots the new coat of pitch be applied before the roof begins to leak.

The discussion, which turned on roofing, flashing, gutters and related subjects, showed very general interest in roofing questions. Mr. G. C. Larson (C., St. P., M. & O. Ry.), Spooner, Wis., reported that a tin roof on an elevator, placed in 1886, and painted every three years, is still in good shape. Mr. C. W. Richey (P. R. R.), Allegheny, Pa., stated that he had found tinned nails, removed from an old roof after 20 years' service, were in an excellent state. Mr. J. M. Canty (B. & M. R. R.), Fitchburg, Mass., gave it as his experience that copper or galvanized iron nails and fastenings in roundhouse roofs do not last. He had found brass screws in a smoke-jack to be quite lasting, and has heard of thin brass sheet being used for flashing. Mr. Penwell uses copper nails of No. 9 wire size, which are much thicker than ordinary copper roofing nails and give very much longer service; he finds that copper gutters and cornices on roundhouses do not last, and require early removal. Another mentioned the case of a roundhouse roof in Omaha, Neb., flashed with copper, where the flashing was eaten away in two years; it was replaced by a flashing of two thicknesses of roofing paper with tar. Mr. J. H. Cummin (L. I. R. R.), Jamaica, N. Y., said that the Morris Park roundhouse, which had a slate roof on steel trusses, had the roof go to pieces very soon, so that it was replaceed by a flat roof on timber trusses. Gutters of 16-oz. copper did not last four years. Lead-lined ventilators, under 5-yr. guaranty, did not last through their guaranteed life even though replaced by copper ventilators. The trouble with gutters is avoided by forming the gutters in the roof, which the Long Island is now practising. For flashing on roundhouses, only roofing paper or felt is effective. The practice of forming gutters in the roof, or doing without gutters entirely, was also reported by Mr. Richey for the West Penn. Mr. W. M. Clark (B. & O. R. R.), Warren, O., stated that Ruberoid and other patented roofings are apt to crack over the joints of the sheathing unless the latter is laid tight-jointed, well matched or ship-lapped. Mr. A. E. Killam (Intercolonial Ry.), Moncton, N. B., stated that he has found 20-oz. lead flashing perfectly satisfactory, even in roundhouse service. On the Intercolonial roundhouse roofs are laid with tight matched sheathing, which probably gives little chance for the gases to reach the roofing and flashing; a prepared roofing of asbestos, asphalt and tar is used, costing about $6 per square. The roofs last 25 to 30 years, even to the flashing. Only galvanized nails are used in the roof.

PROTECTION OF WATER TANKS AND PIPES FROM ACTION OF FROST.—A summary of this committee's report will be printed in our next issue. The discussion at the convention showed that the amount of trouble had with water tanks is very different on different railways, and does not seem to have any close relation to average or minimum winter temperatures. The amount of attention given to the tanks in winter as a regular measure may have something to do with this fact. One member reported less trouble with tanks supplied from springs than with those supplied from creeks or rivers. Mr. H. Rettinghouse (W. C. Ry.) has a steam hose hung at each tank in winter, and a particular local train has the duty of blowing ice out of the outlet pipe on each trip, or if necessary an earlier train can do the work. Mr. J. P. Canty (B. & M. Ry.) reported that iron tanks, of which he has a number, give no more trouble than wooden tanks. Mr. A. E. Killam (Intercolonial Ry.) has no trouble whatever from water tanks freezing, although at one point temperatures of —42° occur. The tanks are 4-in. white pine (spruce is found not so good), have air-space at top and bottom, and thoroughly protected vertical pipes. Mr. R. H. Reid (L. S. & M. S. Ry.) has not seen a tank on his line freeze up in 15 years. A careful inspection in fall is credited with some of this result.

PILE AND FRAME TRESTLE BRIDGES.—While there was no report on this subject, the desire was expressed to collect in the records of the association standard plans of trestle bridges, and it is likely that some such standards will be contributed during the coming years. Mr. W. O. Eggleston (Erie Ry.), Galion, O., stated that his road is preparing standard trestle plans which will probably be available by next year. Several members related observation of poor or even unsafe trestles in regular service, and the impression was created that a collection of standard plans, with data as to designed loading, etc., will be of specific value to railway practice.

The protection of wooden bridges against fire received some discussion in connection with the subjects Steel Bridges, and Fire Protection. Mr. Rettinghouse reported trial of a protection consisting of roofing paper laid on 4 × 4 timbers between ties, covered with crushed stone. Mr. Reid reported a similar method which has been tried on the Lake Shore: 2 × 4 joists were used between the ties, and the crushed stone was placed direct on these; between main and guard rail (in the flange-space) this decking was omitted, and sheet-steel used instead.

STEEL BRIDGES.—An inquiry made by this committee among railway bridge engineers and supervisors, with a view to collating standard practice in matters of interest primarily to the supervisor, yielded but 15 replies out of 150 inquiries. The report, as far as it goes, is nevertheless cogent and valuable; it is reprinted practically in full elsewhere in this issue, together with special remarks communicated by Mr. J. P. Snow (B. &. M. R. R.), Boston, Mass., Mr. R. H. Reid (L. S. & M. S. Ry.), Cleveland, O., and others. The question of hand vs. pneumatic-hammer riveting gave rise to some discussion at the convention. Mr. B. M. Hudson (St. L., K. C. & C. R. R.), Union, Mo., claimed that a pneumatic hammer could not give as good results as an 8 or 9-lb. maul, a view in which one or two others joined. Mr. Reid, on the contrary, held with many others that pneumatic-hammer riveting is faster, cheaper, and tighter than the best hand riveting. He placed the limit for riveting at ⅞-in. × 5 ins., or in some circumstances 1-in. × 6 ins. Cold riveting can be done to a far higher limit, say 2 or 3 ins. × 10 ins., but requires very powerful presses.

FIRE PROTECTION.—No report was rendered on this subject, but a lively discussion arose on the convention floor. Keeping the surroundings of trestles, insides of freight houses and offices, dead spaces under station buildings, etc., clear of combustible rubbish, was repeatedly emphasized, as was also the necessity for provision of hose, fire-pails, hand grenades and water-barrels in the appropriate places with *rigid* inspection of their continued serviceability. Numerous stories were told of fire pails found empty, lost, [illegible] locked up, of water-barrels found [illegible] "fire extinguishing" appliances found [illegible] the like. Mr. Killam stated that [illegible] colonial, where trestles are provided [illegible] barrels at short intervals and in addi[illegible] end a half cask sunk in the ground, [illegible] tice to fine the section men $1 for [illegible] found empty. Water is not kept in th[illegible] the winter, and no fires have occu[illegible] that season. Special care is taken [illegible] ties on bridges in good condition, repl[illegible] as soon as rot shows in a corner. Ch[illegible] tinguishers and hose reels are provid[illegible] ings. Most fires in buildings are trace[illegible] roofs or to accumulation of shavings, [illegible] buildings. While shingle roofs last lo[illegible] out paint, it is advisable to paint them [illegible] for fire protection. Mr. B. F. Pickering [illegible] R. R.), Sanbornville, N. H., has found [illegible] to whitewash shingle roofs where th[illegible] painting is not warranted; this acts bo[illegible] servative and as protection against fir[illegible] H. Cummin (L. I. R. R.), Jamaica, N. [illegible] scribed the fire protection of the 4-mi[illegible] over Jamaica Bay to Rockaway Beach, [illegible] third rail electric system has recently [illegible] stalled. Three fire stations have been built on this trestle, each equipped with a two-man hand car fitted with pump, 20 ft. of suction hose and 75 ft. of discharge hose. Only a week after their installation they served to save part of the trestle and some adjoining buildings. Boxes of wet sand are placed at intervals along the trestle (in place of water-barrels, considered dangerous on account of the third rail). The road has its fire-protection under a retired chief of the Brooklyn Fire Department who has charge of a complete fire organization and has jurisdiction over the equipment. The Jamaica Bay trestle, it should be noted, is built wholly of creosoted timber; untreated wood lasts but a very short time in the waters of that locality.

PRESERVATIVES FOR WOOD AND METAL.—The committee report on this subject is anything but comprehensive, dealing only with wood preservation, and with this only in general terms. However, the report contains some points worth noting, as do also supplementary remarks submitted by two members and abstracted below in conjunction with the report:

The subject of wood preservation is one that requires a great deal of discussion and study to be thoroughly understood; even then complexing questions keep arising continually. Conditions vary so in different locations that one form of treatment that is successful in some certain place would be an utter failure in others. There is a too common error of trying to make one standard form of treatment cover all conditions. Many have an idea that to preserve wood a certain routine of work has to be complied with, and stop at that. No attention is paid to the condition of the material either before or after treatment. The required routine has been fulfilled and that is all that is necessary.

Wood preservation, to be thoroughly successful, must be looked at from a more scientific standpoint in the future than in the past. It must be something more than a mere mechanical operation. Climatic and soil conditions and characters of the woods for treatment will have to be carefully studied, and all the surrounding conditions governing the life of wood in the localities in which it is to be placed taken into consideration in order that a treatment may be applied to suit such conditions.

Of all the different processes used in this country the most universally used is the dead oil of coal tar or creosoting process and the zinc chloride or burnettizing process, the latter being used almost exclusively for the preservation of ties. The creosoting process is coming into almost universal use for the treatment of piling and timber for salt water work, as a prevention against marine insects, which are very active, especially in southern countries. It is also being used to a large extent on all pile and timber trestles as a preservative against decay. To a large extent it has been successful, but not as much as it should have been, owing to the fact that lots of the work was done in a careless manner and possibly with a creosote oil that did not contain the proper ingredients for the prevention of decay or the attack of marine insects.

Different ways of applying the creosoting process have been tried, and the one most in use at the present time is that of first steaming the timber with live steam to liquify all resinous matter and evaporate the sap and moisture contained. A vacuum pump is then applied and vacuum being carried for a given length of time, maintaining heat in the cylinder by means of superheated

steam circulating through heating pipes distributed throughout the sides and bottom of cylinders; to them apply the creosote oil under pressure. In treating the softer woods, such as loblolly, short-leafed and long-leafed yellow pine, this process is fairly successful on account of the timber being open grained and easy of access for penetration of heat; also on account of there being a great deal of elasticity in the character of wood, allowing of considerable shrinking during the seasoning process without badly checking or splitting of the timber. With the more firm and closer-grained woods, such as Oregon pine, red fir, etc., especially when the piles and timbers are of large dimensions, the steaming and the vacuum process is a complete failure, on account of the heat failing to be carried to such an extent in order to reach the center of the timber so it can be thoroughly sterilized. The outcome of this treatment is that the timber is charred to such an extent in order to get it dry, or that there was not enough elasticity in the wood to permit the shrinkage, thereby splitting and checking the wood to such an extent that it is useless for being placed in any structure.

It has been found that these firmer woods can be treated successfully by using a process similar to Boulton's method; that is, of boiling the timber in oil, thus using the oil as a medium for conveying the heat to the timber, instead of applying it direct as when live steam is used. The process varies from the Boulton method by eliminating the use of a vacuum pump, for drawing off the vapor, as it comes off of its own accord, discharging into a surface condenser through which cold water is circulating, thus creating its own vacuum. The vapor after becoming condensed is deposited in a hot well, and by having a gage glass attached close attention can be kept of moisture being extracted from the charge under treatment in order to determine the dryness thereof.

Treating in this manner is applicable to all classes of timber, both close and open grained. It takes no longer than the steaming and vacuum process and there is no liability of affecting the tensile strength of the material as the desired result can be obtained with very low-temperature, not running over 220° F., when with the steaming process, to get the same result, the temperature would have to be carried to 280 or 300°, which is detrimental to the wood fiber.

(J. F. Parker, General Foreman, B. & B. Dept., Los Angeles Div., A. T. & S. F. Ry. Co.): Formerly we used redwood where wood came in contact with the ground, but of late years, on account of redwood becoming scarce, of poor quality, and of high price, Oregon pine has taken its place, which is short lived without the application of some preservative. We have used creosoted piling in both bridge and wharf construction with good results. In Santa Fe wharf at San Diego we have some Oregon pine creosoted piles still in service which were driven in 1887. There the limnoria is very destructive, while the teredo gives us very little trouble.

We have tried several methods and expended considerable experimenting on pile protections for wharves without success, and we are now encasing them in a cement mortar jacket 2 and 2½ ins. thick from the mud up to high water line. This is expensive, costing $1.10 per lin. ft., but it does the business. We use Gillingham cement, one part, and fine sand, two parts, mixed with salt water. It is handled by divers, using sheet iron casings about three feet long, and when one is filled another is placed above it, building up in this way to the desired height, the mortar being lowered in buckets to the divers. In about six days the cement is set enough to allow the cases to be taken off.

As a preservative for piling and timber in bridges, of course creosoting is the real thing. We have some piles with this treating which have already outlasted two sets of untreated piles. We have also found that salt is an excellent preservative for piles and timber when placed in contact with the ground, by using old material from the wharf at San Diego, which had been soaked in salt water for a number of years. The water in the bay is very salt, as there are no running rivers emptying into it.

Of late years we have extensively used crude oil in bridge repair work, on framed bents and decks, also on wooden spans, with excellent results. The oil being applied heavily with brushes it adds very little to the labor cost, as the oil is cheap and is slapped on by the cheapest men in a gang. It penetrates the wood and prevents rotting and checking. At one time we used coal tar, but found it was not a success, as it formed an outside coat, closed the pores of the wood and caused dry rot inside.

Our experience here with preservatives for metal has not been very extensive. We commenced the erection of steel bridges here in 1896 and used a paint composed of crude oil and asphaltum heated together. This was not a success and afterwards cost more to remove it than the original work. This composition chills very quickly, and in the early morning and in the latter part of the day the workmen would get it on too thick, and in the middle of the day when the metal and weather was warm they would get it on too thin. We also painted steel tanks with this preparation. In hot weather it becomes soft and runs down to angles and shelves on bridges, gets filled with dust and dirt and forms a substance to hold moisture and rust the steel. On all our structures where this was we have cleaned it off quite thoroughly and applied "Silica Aluminum Paint" (a locally manufactured paint made from volcanic rock and boiled linseed oil), and common "Brown Mineral" paint with fairly good results. In 1897 we painted a large oil storage tank with the latter, two coats, using an air spraying nozzle. This tank is at Los Angeles and it is in good condition to-day. Three years ago we painted a 38,000-barrel oil storage tank with red lead paint; this is wearing splendidly. We have never used any of the patent paints which are so extensively advertised.

(J. P. Snow, Bridge Engineer, Boston & Maine R. R., Boston, Mass.): It seems to me that good judgment in the selection of timber and the partial protection of that most exposed, with a view to prolonging the natural life of the structure, say for one and one-half the usual period, is likely to produce more beneficial results than the advocacy of costly preserving methods.

To begin with ties: In every lot there will be those which are not so good as the best, but too good to reject. These, including the sappy and open-grained ones, should be sorted out and used on the short bridges, or, if only one long bridge is being re-tied, should be put together at one end of the bridge, with the idea of their not lasting so long as the rest. A similar selection of trestle stringer timbers will result in prolonged life of the part made of better timber. We all know of the renewal of the whole of many structures on account of a few decayed sticks.

It is well known that timbers in a vertical position will last much longer than horizontal ones. On this account the posts of framed trestles will last much longer than the caps. If we cover the caps with zinc their life will be prolonged to match the posts. Horizontal timbers suffer much from sun checks, which serve as inlets for water, to feed the growth of the mycelium fungus. If the tops of such timbers are mopped with a penetrating, non-drying oil it will prevent much of this checking; and, if this oil is at the same time antiseptic and non-volatile it will do much to retard decay.

A wash that can be mopped onto timber after it is framed, that will do some good, is a great desideratum. It can be used with little cost and will be approved and allowed by the railroad management when more costly treating will not. Many such washes are advertised, but they are useless unless used with good judgment. Creosotes eat out iron and are wasted rapidly in the sun. Salts of many kinds are dissolvable in water and hence will be washed out by the rain. A solution of paraffin has been used to a considerable extent by the Boston & Maine and the City of Boston on bridge planking which is covered with sand and paved. This has been removed in perfectly sound condition after 20 years' service. It, however, is not recommended for exposed timber, as the sun and rain destroy its efficiency. An emulsion of paraffin or other antiseptic oil that will spread easily, penetrate well, and neither dry up, wash out nor form a coating on the timber, is greatly to be desired.

Some information about the protection of metal bridge floors from the corrosive action of refrigerator car drippings is contained in the report on Steel Bridges, reprinted elsewhere in this issue.

COALING STATIONS AND CINDER PITS.—A partial report was submitted by this committee, Mr. W. B. Causey (C. & A. Ry.), Bloomington, Ill., chairman. On one road, using mainly chain machinery driven by gasoline engines, a cost of handling of 4.3 cts. per ton was found.

The committees not noted above either did not report or submitted progress reports containing no pointed information.

The election of officers for the coming year endorsed the ticket selected by the nominating committee, as follows: President, J. E. Sheldon, N. Y., N. H. & H. R. R., Providence, R. I.; Vice-Presidents, J. H. Markley, T. P. & W. Ry., Peoria, Ill.; R. H. Reid, L. S. & M. S. Ry., Cleveland, O.; R. C. Sattley, C. & N. W. Ry., Chicago, Ill., and J. P. Canty, B. & M. R. R., Fitchburg, Mass.; Secretary, S. F. Patterson, B. & M. R. R., Concord, N. H.; Treasurer, C. P. Austin, B. & M. R. R., Medford, Mass.; Executive Committee, H. Rettinghouse, W. C. Ry., Fond du Lac, Wis.; C. W. Richey, P. R. R., Allegheny, Pa.; A. E. Killam, Intercolonial Ry., Moncton, N. B.; J. S. Lemond, Southern Ry., Atlanta, Ga.; H. H. Eggleston, C. I. Ry., Anderson, Ind.; and F. E. Schall, L. V. R. R., South Bethlehem, Pa.

A CASE OF BROKEN STEEL RAILS ON A BRIDGE.*

By Thomas Andrews, F. R. S., M. Inst. C. E.

The author received from a railway company the fractured portions of a steel rail which had broken in main-line service on a bridge, and he made the following investigation to determine, if possible, some of the causes leading to the breakage. It was stated that the rail was made by the acid Bessemer process, and from hematite pig iron. It had been laid on the main up, or the south-going line, on the bridge, on longitudinal timbers. The life of the rail was eleven years and five months.

The length of the rail was 30 ft., the original section of the rail was of the ordinary standard bull-headed type of 90 lbs. per yd. (see Fig. 1); and the present section was 82.17 lbs. per yd.; this shows an average loss of about 0.69 lbs. per yd. per annum, from wear and corrosive action. It had not been laid on ballast, and the track was level.

The trains taking the rail were under full steam at an average speed of from 15 to 20 miles an hour. It had not been subject to the skidding action of braked wheels. It had fractured in two places; Fracture No. 1 being 2 ft. 1 in. and Fracture No. 2 being 4 ft. 4 ins., from the end of the rail first taking the trains. It will be thus seen that the two fractures were about the same distance apart as the two first chairs at the on-going end of the rail.

An approximate estimate was made of the total traffic weight which had passed over the single line of rails of which the broken rail formed part. It was estimated that a total of about 296,000,000 tons had passed over the single track during the time life of the rail; dividing this by two gives a total weight of 148,000,000 tons which had rolled over and been actually borne by the fractured rail.

GENERAL EXAMINATION.

On making a careful general external examination of the rail it was noticed that the center of the first supporting chair at point A (see Fig. 2) was about 10 ins. from the on-going end of the rail, and the center of the next chair at point B was about 2 ft. 6 ins. from the center of the last-mentioned chair. The relative distances of the fractures from the rail end and from the supporting chairs will thus be seen.

It appears probable, from the indications afforded, that the rail first broke at Fracture No. 1 (2 ft. 1 in. from the on-going rail end), from the sudden stress of an on-coming train. The adjoining on-going portion of the rail, being thus released from the support afforded by the first chair and end fish-plates, would form the overhanging end of a lever, whose fulcrum would be the next or second chair, and this unsupported overhanging fractured end of the rail would have to bear the sudden impact of the engine tires, and thus, probably, Fracture No. 2 would be produced.

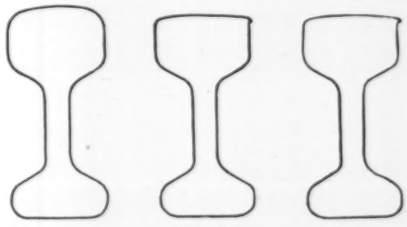

Fig. 1.

Original Section of Rail. 90 lbs. per yard.	Section of Rail at Fracture No. 1. 82.17 lbs. per yard. Loss in weight, 0.69 lbs. per yard per annum.	Section of rail at Fracture No. 2. 82.17 lbs. per yard. Loss in weight, 0.69 lbs. per yard per annum.

Fracture No. 2 may, however, have been produced with the rail face in compression. The exceedingly smooth and polished appearance of portions of the adjacent faces of Fractures No. 1 and No. 2, due to internal abrasive and grinding action caused by the vibration of passing trains, as also the lipping of the rail face at Fracture No. 1, afford indications that the rail had apparently been in either a wholly or a partially fractured state for some time before the discovery of a final fracture. The ends of the fractured portions of the rail had apparently only been held together, subsequently to the actual breakage, by the support afforded by the adjoining chairs, and by the somewhat peculiar hollowed nature manifested on the faces of each fracture, which caused the adjacent fractured faces to somewhat interlock with each other, and thus to resist to some extent the vertical pressure of passing trains. The author has noticed similar cases of broken rails having thus been held together for some time after fracture, in course of some examinations he has recently made, for two of the chief English railways, of two rails which had fractured in two different tunnels.

The rail had reduced in vertical height from wear to the average extent of about $^{9}/_{32}$-in. at Fracture No. 1, and to the extent of about $^{5}/_{32}$-in. at Fracture No. 2.

A careful low power examination of the rail face showed it to be in fair working condition, and it was generally free from the fine transverse hair cracks which the author has sometimes found on the faces of rails which have endured the stress of heavy traffic for a prolonged period. On the rail face at Fracture No. 1 the edge of the fracture had lipped and been turned back in a strip by the passage of on-going trains, subsequent to

*Condensed from a paper read before the Iron & Steel Institute.

the final fracture; this shows that trains had passed over the rail for some time after the actual fracture had occurred.

The considerable corrosion noticed, on the under side of the rail bottom, has probably been due to the local galvanic action which is excited by contact in moisture between the steel rail and the cast-metal chairs.

The appearances of the opposing faces of Fracture No. 1 are given on Figs 3 and 4.

Fig. 5 illustrates Fracture No. 2. The upper portions of the rail head are seen to have broken with a clean-cut surface, and the fractures generally showed a brittle nature, except in some local places.

The chemical analyses of this rail present features of considerable interest. The combined carbon, sulphur,

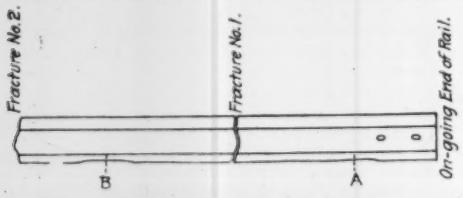

Fig. 2. Side Elevation of Broken Rail.

The center of the first supporting chair, A, was 10 ins. from the on-going end of the rail, and the center of the next chair, B, was 2 ft. 6 ins. from the center of the last-mentioned chair. The relative distances of the fracture from the rail end and chair supports will be thus seen.

and phosphorus had locally segregated, to a considerable extent, around the outer periphery forming the contour of the rail head.

In this situation, and also in the bottom flange of the rail, the percentage of combined carbon was excessive for rail steel, and the silicon was more than desirable; moreover, the manganese was present in very great excess; the sulphur and phosphorus were satisfactory.

On comparing the chemical composition of the wearing surface of the rail head and rail head sides, both adjacent to Fractures No. 1 and No. 2, with the composition of the rail at the junction of the head with the web, in the same vertical sections, it was found that considerable local segregation of the chemical constituents had occurred, some of the elements having apparently, in course of the thermal treatment of the rail from the ingot to the finished state, migrated outwards, and transversely segregated near the outer surface of the rail, which has produced a rail of very diversified non-homogeneous composition throughout the mass. The rail has consequently proved to be of an unsatisfactory character.

This rail is in fact a typical sample of a segregated high carbon and high manganese rail, which class of rails almost invariably have a tendency to suddenly fracture in main-line service. The author has recently examined, for several English railway companies (for whom he acts as consulting metallurgical chemist and testing engineer), rails of this type, which have shown brittle qualities and have suddenly broken after comparatively short main-line service. The rail bears internal evidence of having been originally made from good pig iron, but in the manipulation an excessive percentage of combined carbon and manganese has been allowed, which has been detrimental to the physical structure and permanent endurance of the rail.

Portions were machined for the tensile tests from the top of the rail head, from near the junction of the rail head with the web, and from the bottom flange, these test-pieces being taken from near to Fracture No. 1. Other portions were machined from the top of the rail head, near the junction of the rail head with the web, and from the bottom flange of the rail, adjacent to Fracture No. 2.

The results of the tensile tests show that the rail was entirely lacking in uniformity of physical structure. The maximum stress near the top of the rail head, at Fracture No. 1, was very high, the elongation was extremely low, and the physical properties of the rail at this point were but little removed from the properties of cast metal. Lower down in the vertical section, near the junction of the rail head with the web, the physical properties were here, locally, entirely different from those near the top of the rail head. At this point the maximum stress, elongation, and the reduction of area were satisfactory, and were such as are found in good rail steel.

In the bottom flange of the rail the maximum stress was extremely high and far beyond what is desirable in good rail steel; the elongation was very poor, as was also the reduction of area per cent.

The maximum stress at the top of the rail head, adjacent to Fracture No. 2, was very much higher than is desirable for good rail steel, and the elongation was somewhat low. The physical properties at the junction of the rail head with the web, near to Fracture No. 2, were of a satisfactory nature and representative of the structure of good rail steel.

In the bottom flange of the rail, adjacent to Fracture No. 2, the maximum stress was very high, and the elongation was extremely low, not much better than cast metal.

These results show that the segregated condition of the chemical elements had very materially affected the physical structure of the mass of the rail, and had resulted in a rail of a brittle character. There was no homogeneity of physical structure throughout either the vertical or longitudinal section of the rail, and this lack of uniformity the author considers due to the very high percentages of combined carbon and manganese which prevailed in the chemical composition of the rail head and bottom flange. The results of both the chemical analyses and the high power microscopic examinations confirm the results obtained by the above physical tests, and indicate the undesirability of using rails of a high percentage of combined carbon and manganese (even though comparatively free from excess of sulphur and phosphorus) on the permanent track.

With regard to the cause of external local segregation in steel rails, the author has demonstrated that local internal segregation mostly exists in those rails which represent the top part of an ingot. During the cooling of large steel ingots he thinks that in addition to local segregation, near the top of an ingot, there may sometimes be a further transverse migration of the carbon and other elements from the central axial part towards the exterior of the ingot. This tendency to external migration of the chemical elements he considers is most likely to occur near the bottom or wider part of the ingot. Now, when such an ingot is rolled into a rail, say 90 ft. long (which is finally cut in 30 ft. lengths), that rail representing the bottom of the ingot is likely from the above cause to manifest a condition of local external segregation, as distinct from interior axial longitudinal segregation; whereas, the rail representing the top portion of the ingot would probably afford indications only of internal local axial segregation.

The author further thinks that the keeping of steel ingots for any lengthened period in "soaking pits" tends to promote local segregation of some of the chemical constituents.

If either internal or external local segregation arising from any cause is present to any considerable extent it becomes a serious source of danger leading to the sudden fracture of rails.

The fractured rail now under consideration affords a practical example of the risk arising from rails of this type, and this fractured rail is in fact a very marked type of external local segregation, which condition has apparently promoted the sudden fracture of the rail. The author considers that this state of segregation was initially derived from the ingot, and that it has simply been continued in the rail during the final process of manipulation.

SUGGESTIONS.

(1) The author made a careful examination of the general section of this rail, and has compared it with other rails, and he ventures to suggest that the rail web in the original section is rather too thin in proportion to the section of the rail (the web being only $^{21}/_{32}$-in. thick).

He thinks that in rails of this type, the web should not be less than $^{3}/_{4}$-in. thick, or at least $^{11}/_{16}$-in., and the width of the rail head may, he considers, with advantage be increased to not less than 2⅝ ins., and the width of the bottom flange proportionately increased.

He has for some years past recommended, with advantage, to some of his railway clients, a thickening of the web and widening of the rail face and bottom flange, and the result has been satisfactory and reduced the breakages in practical main-line service.

(2) The author thinks it would be desirable to use a heavier section of rail for bridge or tunnel traffic than the section of the rail now examined, and he prefers for bridge work to use a wide, flat-bottomed rail of heavy section, as he believes heavy-sectioned, flat-bottomed rails, on longitudinal sleepers, will yield more reliable results in main-line traffic for bridge or tunnel service than the ordinary bull-headed type of rails resting in chairs. If, however, bull-headed rails with transverse sleepers are employed, it is very desirable to have in tunnels or on bridges a greater number of sleepers placed close together, and also to have specially large sleepers to match the fish-plate joints at the ends of the rails.

In case rails of a heavier section are used, it is important that the ingots from which they are rolled should have a proportionately increased transverse sectional area, to ensure that a proportionately increased amount of rolling work is put on them. Merely lengthening the ingot to get the increased weight in section does not allow of equal work being put onto the finished rail as compared with rails of less section.

(3) In view of the considerable corrosive deterioration of rails on bridges, and also in tunnels, it will be found advantageous to protect such rails by primarily painting them two or three coats of good paint. Recent experience has shown this to have beneficial effects, far outweighing the comparatively small cost and trouble involved.

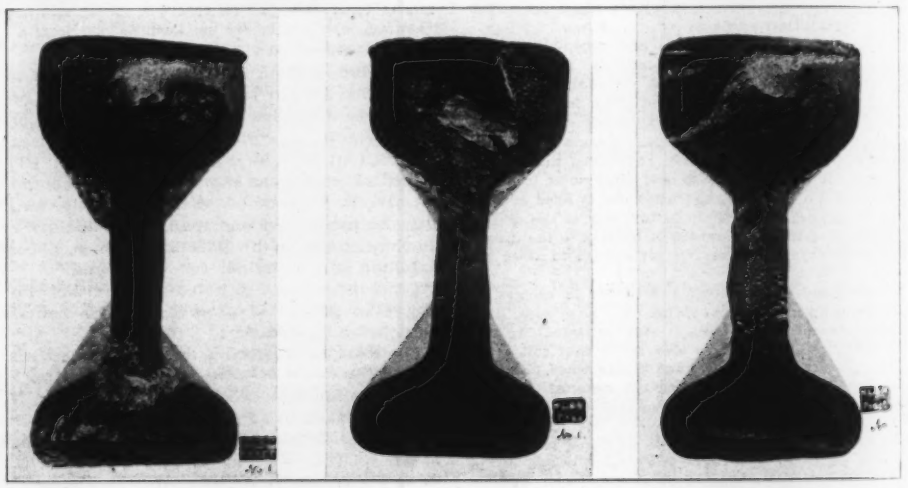

Fig. 3. Face of Fracture No. 1, as Seen Opposite the Direction of Passing Trains.

Fig. 4. Face of Fracture No. 1, as Seen in the Direction of Passing Trains.

Fig. 5. Face of Fracture No. 2, as Seen Opposite the Direction of Passing Trains.

FIGS. 3, 4 AND 5. FRACTURED END OF STEEL RAIL IN TRACK 11½ YEARS. TRAFFIC CARRIED, 148,000,000 TONS.

WATER POWER AND ELECTRIC GENERATING plants on the Winnipeg River are coming into prominence for the supply of electric current for railway, light and general power purposes in Winnipeg, Manitoba. The Winnipeg General Power Co., which is closely allied with the Winnipeg Street Ry. Co., is constructing a plant at Lac du Bonnet, near the mouth of the river, where a fall of 40 ft. is obtained and about 30,000 HP. is being developed. This plant, the transmission line (about 70 miles) and the Winnipeg sub-station are well advanced, and it is expected that current will be available in December. Provision is made for enlarging the plant to double the above capacity when required. The plant was originally designed by Mr. Hugh L. Cooper, Consulting Engineer, of New York; Mr. F. S. Pearson, also of New York, is the present Consulting Engineer and Mr. Walter H. White is Resident Engineer. The city of Winnipeg is also arranging to establish a power plant of its own on the Winnipeg River for city lighting, surplus current to be sold approximately at cost for power purposes in order to encourage the establishment of manufacturing enterprises. Careful investigations have been made by Col. H. N. Ruttan, City Engineer, and Mr. Cecil B. Smith, Consulting Engineer for the Hydro-Electric Commission of Ontario. Under its charter the city cannot undertake work of this kind outside of the city limits, and to obtain the necessary powers would involve long delay. It is proposed, therefore, to have a construction company organized by leading local financiers to carry out the work according to the city's plans, with the agreement to sell power at cost; the city would then acquire the plant when in operating condition. The company or "power association" has the following directors: J. H. Ashdown, John Arbuthnot, A. Macdonald, D. W. Bole, R. T. Riley and E. L. Drewry. A third power enterprise is that of the Great Falls Power Co., backed by Mr. H. M. Byllesby, of Chicago; the charter has been extended until 1907 and engineers are now at work on the surveys and plans. A development of 50,000 HP. in units of 10,000 HP. each is proposed. The fourth project is that of the Lac du Bonnet Development Co., which has already established brick works and other industrial enterprises and has rights of water power development. Dr. Gray, of Winnipeg, is President of this company.

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The article which is published on the first pages of this issue may serve to call particular attention to the one-sided development of engineering literature. The professional literature available for the instruction of the engineer is surely voluminous enough at the present day. No one better appreciates that fact than the busy editor. Every mail brings its heavy burden of technical periodicals, papers read before engineering, scientific and trade organizations, to say nothing of original contributions, good, bad and indifferent.

We are revealing no secrets and making no very original criticism, when we say that very much of this mass is mere duplication of what has been done before, and it is an injury rather than a benefit to the profession since it makes it just so much harder for the searcher to find really important and valuable matter.

But with all the great volume of technical literature there is still a lack in certain fields; and one of these fields of no small importance happens to be that of gas-holder design. One will search a long time to find any published paper of direct practical value to the working engineer treating of the design of a modern large size gasholder. The knowledge exists, of course, but it has been more or less carefully guarded as part of the stock in trade of the companies which undertake the building of these structures. That this attitude is a mistaken one and one which will eventually be abandoned, there is every reason to believe. In the field of bridge work, of steam engineering, of electrical motor design, there was once the same attempt at secrecy; and it has all been swept away. Developments in these fields are promptly put on record in engineering literature, and the same thing should be true of other fields.

This is why the editor who succeeds in obtaining information and data in some department of engineering hitherto neglected takes particular pleasure in laying it before his readers, sure that even though it may be of direct interest to but few, to those few it will be of very great value.

Further than this, it is perhaps not often realized that the powers of the editor are limited. He can only publish such matter as he can obtain. If no one will write on any subjects but bridges and boilers and bolts, then bridges and boilers and bolts must furnish the bill-of-fare for his readers. We want to emphasize the demand for information regarding the departments of engineering concerning which nobody has yet written. There is a vast amount of practical knowledge that has not only never gotten into the textbooks, but has never made the first step towards them through the pages of the technical journals. The engineer, young or old, who can make some real contribution to professional literature in some of these untrodden fields will find that he has accomplished far more for himself in the way of reputation than would result from any paper in the fields with which everybody is familiar.

By way of additional illustration to the above appeal, there comes to our notice a letter containing an urgent request for "published data on the allowable load on knife-edges for heavy scales."

Very likely this information may have been somewhere, by somebody, put on record in print; but search through the ordinary sources of information, such as Kent's "Pocket-Book," and the published indexes to periodical literature does not reveal it, and we shall be glad to hear from any of our readers who can furnish the information. Incidentally we may add that some engineer in possession of the necessary information ought to write a complete paper on knife-edge bearings, and contribute it to this journal or the Transactions of the American Society of Mechanical Engineers.

Some of the readers of Engineering News may chance to remember an old game, popular among the children of thirty years ago, called "the Checkered Game of Life." It was played upon a board marked off in squares representing all conditions, from "Infancy," where each player began, to "Happy Old Age," a much desired goal on the opposite side of the board. One square on the board, which each player desired to reach, was marked "Wealth," and the two ways of reaching it were through two other squares, marked, respectively, "Industry to Wealth" and "Government Contracts to Wealth."

At the time of which we write, not long after the Civil War, there was much excuse for the popular impression, which the children's game above referred to well illustrates, that "Government Contracts" were a sure and short road to wealth. But at the present day, there is another side to the story. "Government contracts" may lead to wealth; but they may lead also to financial ruin. We are referring of course in all this to contracts under the Federal Government. It is, we believe, a fact that work for the United States is done much more economically, efficiently and honestly, and with a much smaller percentage of loss through fraud and corruption than was the case thirty to forty years ago.

There still remains, however, a popular belief that Government contracts lead to wealth. So general is this impression that the U. S. Reclamation Service has found it advisable recently to issue a formal statement, warning those who bid on its work not to present such bids without full knowledge of the conditions, since the letter of all contracts must be rigidly enforced, whether the contractor is making money or losing money. The letter of warning is so full of interest, not only to the particular class to which it is addressed but to contractors generally, that we print it in full as follows:

> There seems to be a peculiar fascination about a government contract and a widespread belief that a person who secures a contract from the government is certain of large profits and easy work. As a result, there are many inexperienced persons who are continually seeking contracts and who, out of their ignorance, frequently succeed in getting into very embarrassing situations. There is nothing more irritating than the effort of inexperienced persons to try to get a contract, and if by chance it is awarded to them, they seek not to execute the work as required, but to shirk the obligation incurred.
>
> The Reclamation Service, having a new class of work, has been put to much trouble and expense by inexperienced or speculative individuals who have, in some cases, made bids ridiculously low and have insisted on having the contract awarded to them in spite of the warning of skilled men that they would incur large losses in carrying out the work specified. These people do not and will not understand that the contracts they enter into are very carefully guarded, and that no discretion or leniency is possible after the contract is signed. They seem to forget that an employee of the government can not modify the contract, no matter how onerous it may be, and that their property and that of their friends who have gone on their bond must be taken by the government in default of the work.
>
> The warnings given these people frequently have been treated with contempt, under the belief that the engineers had some friend they wished to favor. In several instances the lowest bidders have been frequently told that they could not do the work for anything like the amount offered, and that, if they entered into contract they must fulfill it to the letter and spirit. They have laughingly retorted that they know how to do business; have executed bonds, and then have awakened to the dismal fact that they must carry out the law and obligations and can not secure relief. One poor fellow, who should have known better, secured, after great exertion, a contract for hauling supplies over a high mountain range. He put all his possessions and that of his friends into an excellent equipment, but discovered too late that the price he had bid was far below what it would cost to feed his horses and maintain his equipment. He has begged time and again to be allowed to give to the government all of his property, the results of years of hard toil, if his friends could be relieved from liability; but, unfortunately, there is no way by which relief can come to him, and he must day by day see his property eaten up, the bonds being so complete and the terms so exacting that he cannot escape.
>
> In other cases men seek to slight their work, or to induce inspectors to pass it, without full compliance with the terms. There thus results a continuous and exasperating warfare; the man losing money and the government agents insisting that he perform his work according to specifications.
>
> There is no desire on the part of anyone connected with the government to let a contract at less than a fair rate, with reasonable profit. It is far better for all concerned that the contractor make fair wages for his men and a small return upon his capital invested. The engineers of the Reclamation Service, having spent the best part of their lives in such work, know as a rule very nearly what it will cost, and they view with apprehension the incursion into the contracting field of men who have never had experience and who are enamored with the idea of getting a job of this kind.

There is probably particular need for this warning at the present time when the general activity of business and the great volume of new construction in progress is tempting into the contracting field a great number of new men with comparatively limited experience. Besides the explicit warning given above, contractors who are now estimating on work will do well to consider the present general upward tendency of market prices for materials, and particularly the very unusual conditions in the labor market. Every contractor should carefully read the articles by Mr. J. N. Hazlehurst, of Mobile, in our issue of Sept. 21; by Mr. Geo. B. Hazlehurst, in our issue of Oct. 5; and particularly that in the current issue by Mr. W. C. Weeks, describing labor conditions in the Northwest. As many of our readers are aware, there is also a very active demand for labor in the East, and notwithstanding the large shiploads of immigrants arriving almost daily, there seems to be work at good wages for every laborer who wants employment.

This condition is likely to continue, so far as can now be seen, during the coming season; and contractors who are bidding on work must face the prospect of a higher cost for labor, probably, than has ever been experienced. It is a good time to make money in the contracting business, surely, but there are also fine opportunities to lose money. A low bid may land a contract; but it may also land the contractor in the bankruptcy court.

An English engineer calling at this office a few days ago and discussing comparative features of English and American railway practice, referred in most uncomplimentary terms to the flat-bottom type of rail and of American permanent way generally, and made the very astounding prediction that within a few years American railways would be compelled to abandon their present style of track and adopt the English bull-head rail laid in chairs!

It is needless to say to our readers that such a prediction is so absurd as to be ludicrous. It is probably true that the English rail is more firmly held by its chair supports against forces tending to tip it or slide it laterally than is the American rail. That, however, does not prove that a stable track cannot be laid with flat-bottom rails, and it is in fact entirely possible by the use of tie-plates and screw-spikes to make a track with the flat-bottom rail section quite as stable and safe as the English track.

In this connection we reprint in this issue a recent Iron & Steel Institute paper written by an English designer and metallurgist, describing the

breakage of some English bull-headed rails. The author of the paper does not venture to go so far as to condemn the bull-head rail in toto; but he does mildly suggest that he "prefers," for bridge or tunnel work, a wide, flat-bottomed rail of heavy section.

It will probably occur to any American engineer reading the article referred to that the English bull-head rail is very weak to resist bending stress compared with the American flat-bottomed rail. Every rail has of course to act as a girder to carry the wheel from tie to tie; and with its head in compression and its base, in tension the flat-bottomed rail has its metal much better placed than the bull-head rail to take the tensile stress. This really determines the strength and stiffness of the rail, since modern high-carbon rail steel is much stronger in compression than in tension.

That the passenger car of the future is to be built of steel appears now to be generally agreed. It is reported that the Pennsylvania R. R. Co. has decided to contract for no less than 1,500 steel passenger cars. One governing motive in this decision is very likely the desire to have only steel cars run through the system of tunnels under the North and East Rivers in connection with the great new terminal station in New York City. The entire practicability of steel cars has been well shown by those in service in the New York subway, and no railway officer hereafter will be willing to operate wooden passenger cars in a tunnel system, particularly with electric motive power, if it can be avoided.

But for general railway service, too, the steel-frame passenger car promises to so greatly reduce the casualties in wrecks that the railways cannot too soon undertake its rapid introduction. With a clear appreciation of the coming demand for steel cars the American Car & Foundry Co. has already under way new shops at Berwick, Pa., with a capacity of 50 to 100 steel passenger cars per month. The same company is now working on a contract for 275 steel cars for the London underground railway lines.

SOME URBAN AND RURAL ASPECTS OF TYPHOID FEVER.

Disgraceful typhoid fever records are shown for a number of Michigan cities in the August number of the "Michigan Bulletin of Vital Statistics." Thus Escanaba had an average typhoid mortality of 114.3 per 100,000 for the five-year period, 1900-4, with the enormous rate of 360.4 for the last year of the period. Sault Ste. Marie had a five-year rate of 111, "but more persistently high annual rates" than Escanaba. The population of each of these cities was about 11,000 by the State Census of 1904. Menominee, with about the same population, showed an average of 66.9 typhoid deaths per 100,000 for the same five years. The 19 cities having populations ranging from 5,000 to 10,000 in 1904 had an average typhoid mortality of 40.1 per 100,000 for the five years; 8 of these 19 cities averaging over 40 and only 3 averaging under 20 per 100,000 for the period. Of the 6 largest cities in the State, Jackson showed 48.3 and Grand Rapids 44.1 deaths per 100,000 for the five years, their respective populations being 25,300 and 95,718. Turning to more creditable records, we find that of the 6 largest cities Detroit (317,591 population) had the lowest average for the five years, 23.3 per 100,000. This is too high, but we are pleased to note that it is the average of a generally falling yearly rate. In the cities of 10,000 to 25,000 population the five-year averages for the three lowest cities are Muskegon (20,897 population), 18.2; Manistee (12,708), 17.8; Ann Arbor (14,599), 15.1.

The foregoing figures would mean more had we an acknowledged standard of comparison. Recognizing this, Dr. Cressy L. Wilbur, Editor of the Bulletin already named, and Chief of the Division of Vital Statistics, has incorporated in the review from which our figures are taken some figures for American and foreign cities. These are so interesting and instructive that we quote them, noting that some of them are for 11 years, some for single years, and some for 5 years, as stated:

Certain groups of American cities, according to the U. S. Census, gave the following average death rates from typhoid for the eleven-year period 1890-1900: Cities in New England states, 30; cities in Middle states, 32; cities in Lake states, 48; cities in Southern states, 50; cities in Western Central states, 38; San Francisco, Cal., 37. In the extended list of cities showing death rates per 100,000 white population in 1900, the only cases having typhoid rates over 100 per 100,000 or 1 per 1,000, are the following: Allegheny, Pa., 101.9; Charleston, S. C., 103.1; Newcastle, Pa., 147.1; Pittsburg, Pa., 145.5; Pueblo, Colo., 107.8; Youngstown, O., 116.0. So that the fact that at least two Michigan cities had *average* rates of over 100 for an entire five-year period, while another was very close to this limit, is very significant.

When we come to foreign countries, we may note the very low death rates from typhoid fever according to statistics for the year 1902 in the international data published by the English Registrar-General: England and Wales, 12.6; Scotland, 12.2; Ireland, 13.8; Norway, 4.6; German Empire, 7.0; Hungary, 27.3; Netherlands, 8.6; Belgium, 17.8; Switzerland, 6.2; Spain, 45.8; Italy, 34.6. And in certain foreign cities, according to a very valuable table in the "Annuaire Statistique," 1903, of the city of Buenos Aires, there were, for the five-year period 1898-1902, the following rates per 100,000: Buenos Aires, 22.0; London, 14.4; Paris, 21.7; Berlin, 5.0; Vienna, 5.1; St. Petersburg, 80.7; Madrid, 50.0; Brussels, 17.2; Turin, 22.2; Lisbon, 29.4; The Hague, 5.1; Berne, 7.0; Copenhagen, 13.3; Stockholm, 4.3; Rio Janeiro, 15.9; Santiago de Chili, 48.3; Montevideo, 18.8; Havana, 39.3; San Jose (Costa Rica), 74.9; Milan, 46.2 The fact that the greatest city in the world should have so low a mortality from this filth disease, the highest rate since 1885 having been only 18.0 per 100,000 population in 1899, and the rate for 1903, the lowest on record, being only 8.3, would effectually disprove that there is any necessary connection between the massing of population and increased mortality from this disease. Not a single city in Michigan over 10,000 population can show as low a death rate from typhoid fever as London.

After allowing for various facts that tend to make some of these statistics uncomparable, the contrast between typhoid mortality at home and abroad is a great disgrace to the cities of the United States. There is also a marked contrast between the New England and Middle groups of States and the Lake and Southern groups, greatly to the disadvantage of the latter. But even the New England rate of 30 per 100,000 is far too high.

We venture to suggest, perhaps not for the first time, that an average of more than 20 typhoid deaths per 100,000 for a period of years indictates that something is wrong with the public water supply of a city.

In the larger cities, where a few deaths, more or less, do not cause great variations in the rates, the 20 per 100,000 standard might be applied to a single year, instead of to a period of years.

Assuming as intelligent sanitary control of the milk supply and of other means of typhoid infection as our most progressive cities now give to the water supply, the average typhoid mortality ought to fall to 15, if not to 10 per 100,000. But not even the first of these standards will often be attained until a great improvement in rural sanitation is effected. The rural population is largely responsible for typhoid infected water, and primarily to blame for typhoid infected milk. Its careless practices, also, combined with the heedlessness of most "summer boarders," give rise to much of the city typhoid, which is almost invariably higher shortly after the return of city people from their vacations.

In seeming conflict with some of the ideas just expressed are the typhoid statistics for the rural districts, which, as a rule, if not invariably, are lower than those for urban sections. But it must be remembered, to begin with, that death statistics in the country are far less complete than in the city, and that diagnoses of such diseases as typhoid are also less accurate in the country. Moreover, epidemics of typhoid are far less likely in the country than in the city, even when infection arises in the country. This, of course, is due the relative isolation of country people and to what may be termed their self-contained methods of living. The dangers of an infected farm well may be confined to the single family living on the farm, but the water from the well may be used to wash milk cans or water milk, and thus spread typhoid germs to hundreds in the city, against five or ten on the farm itself. In water epidemics the contrasts between rural and city exposure to infection from a farm or country house case are even greater, as witness the Plymouth, Butler, Ithaca and other great typhoid epidemics.

Coming back to the Michigan figures, we think the dangers from rural conditions are well illustrated by the typhoid records of the small cities already cited. The much higher typhoid mortality in the smaller than in the larger cities, and it must be remembered that the contrast would be still greater if the records were as complete in the small as in the large cities) are due in part to the fact that the smaller cities suffer from many evil sanitary conditions within the borders of a nature similar to those in the rural districts, and also that the small cities fail to protect themselves as fully against rural infection as do the large cities.

The conclusion of the whole matter, as applied to Michigan and to other States, is that city and country alike have scarcely begun to realize the typhoid menace that constantly surrounds and invades them, nor to the possibilities of reducing the menace and the ravages of the disease, nor to the duties which the country owes the city and the city the country—for the obligations of sanitary reform know limits neither urban or rural, State or National.

LETTERS TO THE EDITOR.

Ownership of the Mather & Bowen Patent on Concrete Block Construction: Correction.

Sir: I would respectfully call your attention to an error in the title of the cut on page 368, third column, issue of Oct. 12, being Plate No. XII. of my article on "Concrete Building Blocks." As far as I am aware the Mather & Bowen patent is not owned by the American Hydraulic Stone Co. I do not know who owns it.

Yours truly, William M. Torrance

111 Broadway, New York, Oct. 12, 1905.

A Suggestion for Making Concrete Pipe for High Water Pressures.

Sir: Water supply paper No. 143 of the U. S. Geological Survey, by Mr. Quinton, reporting results of tests with reinforced-concrete pressure pipes is very interesting, showing that sweating, even for comparatively small pressure, can probably not be prevented fully without an inside layer of rolled metal or wood. However, it appears, as might be expected, that the main part of the leakage is due to the stretch of the steel rods and consequent cracking of the concrete when the pressure is on. To prevent this it would suggest itself to form the concrete pipes without metal and with thin walls, to wrap the same with steel wires, wound with such initial strain as will amply cover the inside pressure to be expected, and finally to cover the wire with a thin outside layer of concrete for protection, applied in place. The writer would expect good results from pipes thus manufactured and desires to know whether the method has already been tried by some of the readers of Engineering News.

Very respectfully,

Charles R. Steiner,

Assistant Engineer, U. S. Geological Survey.

Pathfinder, Wyo., Oct. 9, 1905.

A Problem in Improving Alinement.

Sir: Some time ago a location problem was given to me by an engineer of wide experience, of which he said he had never seen a satisfactory solution. I succeeded in finding a solution, which he advised me to send to your journal.

Yours sincerely,

W. W. Urquhart, c/o G. Y. P. Edmonton, Armstrong's Party.

Grand Trunk Railway System Engineering Department, Saskatchewan Province, Sept. 1, 1905.

The problem is as follows:

Given a section of located line containing three curves, to find a tangent between the two outside curves, and the points of tangency S and T.

Solution:

In the triangle NfR there is known:

f, a right angle.

N, the intersection angle of the middle curve and the side Nf.

Then

$$fR = NF \times \tan N$$
$$NR = Nf \div \cos N$$
$$\text{Angle } R = 90° - N$$

In the triangle KcR, there is known:

$$cR = cN + NR.$$
The angle R.
The angle $c = 90°$.

Then

$$cK = cR \times \tan R$$
$$KR = cR \div \cos R$$
$$\text{Angle } K = 90° - R.$$

In the triangle KLP there is known:

$$KL = Kc + \text{radius } cL.$$
$$KP = KR - (fR - fp).$$
The angle K.

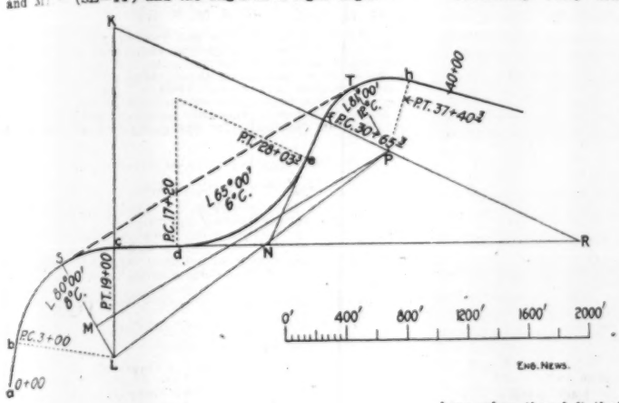
$$\text{Tangent } \tfrac{1}{2}(L-P) = \frac{(KL-KP) \times \text{tangent } \tfrac{1}{2}(L+P)}{KL+KP}$$

$$\text{Angle } L = \tfrac{1}{2}(L+P) + \tfrac{1}{2}(L-P)$$
$$\text{Angle } P = \tfrac{1}{2}(L+P) - \tfrac{1}{2}(L-P)$$

$$\text{Angle } P = \frac{KP \times \text{sine } K}{\text{sine } L}$$

Draw MP parallel to the proposed tangent ST and at right angles to SL and TP.

Then in the triangle MPL there is known the side LP and MP = (SL—TP) and the angle M a right angle.



Then

$$\text{Cos MLP} = ML \div LP$$
$$\text{Angle MPL} = 90° - MLP$$
$$MP = LP \times \text{sin MLP}.$$

Then angle MLP—KLP = the central angle of the amount of curvature to be backed up from c, the old PT, to S, the new PT. Similarly, the central angle of the amount of curvature to be run from f, the old PC, to T, the new PC, equals 90° — (KPL — MPL).

Also, the length of ST is the same as MP.

The Labor Market in Northern Minnesota.

Sir: I read with a great deal of interest the statements of Mr. J. N. Hazlehurst in Engineering News of Sept. 21. To my mind his so-called digression discussing the labor problem is by far the most interesting part of his paper.

One statement made by Mr. Hazlehurst is so directly contrary to the usual experience of employers of common labor that I expect to see that point discussed in later issues of the News. Mr. Hazlehurst says:

With white employees an increase of wages is generally followed by a marked additional effort, but an advance in the negro's wage scale produces just the opposite effect, etc.

While that may be the case with southern whites, it is not true of the class of labor now available in northern Minnesota. At present the labor situation in this locality could hardly be worse. The laboring class is composed of Americans, American and foreign born Scandinavians, a few Finns and Poles. The first mentioned constitute the bulk of the class known as "Lumber Jacks," who prefer employment in the lumber woods and "on the drive," though the exhaustion of timber tributary to navigable streams and the rapid extension of logging railways is reducing the number so employed yearly. During the late summer and early autumn months the men generally go to the harvest fields of the Dakotas on the reduced rates offered at that time by the railroad companies, returning in time for work in the logging camps in the fall.

Having been in this locality a little less than a year I am not prepared to give an extended account of labor conditions, but my experience both as engineer and contractor during the past nine months enables me to speak for that period of time. Wages in the woods for the winter months include board and lodging and range from $26 per month for common labor to $35 and $40 for teamsters and "loaders."

In summer, board in the railroad camps is standard at $4 per week; no charge is made for lodging; wages began in the spring at $1.75; advanced by mid-summer to $2, and are now $2.25 for common labor, with $35 per month, board and "straight time" for teamsters, at which figures they now stand.

For the past year the demand for men has always been equal to, and generally exceeded the supply. During harvest in "Big Dick," as the Dakotas are termed in the vernacular, men could not be had at all, and railroad work almost came to a standstill. As soon as harvest was partly over, or in stricter sense, as soon as the men who had gone to the harvest fields wanted a change, employment agents from the principal northern Minnesota towns went to the Dakotas and personally conducted parties of laborers back to the localities where they were most needed, advancing their railroad fare.

The efficiency of these men, their reliability and their willingness to do an honest day's work is inversely proportional to the wages they receive, and at the present rate of wages the labor cost of a piece of work is more than double what it would be under right conditions of labor supply and demand. It is a saying among employers, and is practically true, that one must have three crews, one going, one coming, and one on the work. The readiness with which these men find employment makes them lazy, inefficient, independent and to the last degree improvident. A man who stays in a camp a month at a time is a rarity—a week is the usual period. They are always 'broke."

Practically every cent paid to common labor goes through the saloons. One saloonkeeper sent our labor checks to our home bank in five-hundred-dollar lots and received his money by return express—to cash more checks. The men as soon as paid (and they usually remonstrate most vigorously against the 75-ct. hospital fee charged) make for the nearest saloon and are in a drunken stupor from that time until their money and credit is gone, and they conclude through necessity to go to work again. And they have no difficulty in finding employers. They arrive at the camp in no condition for work—after feeding up and resting for a day they sometimes take out the same team put in the barn when they left that had been idle during the period of their absence, because of the scarcity of men. To admonish a man for carelessness or wrong doing even in the most civil terms is to receive a gruff demand for "my time."

The cause of these conditions among laborers is presumably the demand for their services and the high wages prevailing. The remedy is the reverse of these conditions. I well remember in 1894 when engaged on railroad construction in this same country, men were plenty, they were civil, efficient and reliable, and the contractors made money that year at prices that would mean financial ruin to-day. Few want a return of those "hard times," yet there are among the employers and better class of superintendents and foremen many who would almost welcome a return of similar conditions in order that common labor might be restored to a more dependable basis.

W. C. Weeks.

Bemidji, Minn., Oct. 12, 1905.

Killing Weeds on Railway Track.

Sir: Noting the query in your issue of Oct. 5 as to a liquid weed killer, I would refer you to "Herbicide," a patent liquid weed killer manufactured by the Reade Mfg. Co., Agricultural Mfg. Chemists, 546 West 22d St., New York City.

This material cost about 60 cts. per gallon by the barrel f. o. b. New York City, and for use is mixed 1 gallon of Herbicide to 19 gallons of water. The solution has no bad effect on ties or rails though it is poisonous to animal life. The solution should be mixed as wanted and sprayed on vegetation by force pump and hose with attached nozzle. The manufacturers advise wetting the vegetation and ground with water in dry weather, before applying the solution. I have used the mixture on tracks and grounds at this place sufficiently to prove that the vegetation is killed, though it does not shrivel up and vanish as claimed by the circulars. The advance of a hot summer which dried up all vegetation cut short the experiments.

I expect to use a considerable amount this winter and spring, as the stuff seems cheap and effective.

Hoping this information may prove of value, I am,

Yours truly,

O. P. Shelley,
Jun. Am. Soc. C. E.

Black Diamond, Cal., Oct. 12, 1905.

Is it Permissible to Caulk or Sledge Loose Rivets in Structural Work?

Sir: I have read with much interest the article on "Workmanship in Riveting," by Mr. A. J. Himes, M. Am. Soc. C. E., printed in your issue of Oct. 19.

I would like to say that my experience in close personal inspection of structural steel under erection, coincides with that of Mr. Himes in every particular. This question of workmanship is one that should receive more attention than it does, and it should be extended not only to riveting, but also to the column bearings where the splicing is not as strong as the column. The writer has found defective column bearings quite as prevalent as loose rivets.

If the workmanship along these lines were brought up to a reasonably high standard it would eliminate most of the serious defects which are too often found at the present time in steel-frame structures.

Very truly yours,

John Stephen Sewell,
Captain, Corps of Engineers.

Washington, D. C., Oct. 20, 1905.

Sir: I have read with interest the Letter to the Editor signed by "Subscriber," published in your issue of Oct. 5 instant under the above title. Noting certain statements in the communication that are not based on facts, I would respectfully request that for the sake of correcting a false impression which might have been formed from your publication of "Subscriber's" letter, you will kindly publish this explanation.

There was no need to submit to you the question covered by the subscriber's communication, as the fact that a column built as described in the first paragraph of "Subscriber's" letter would not be considered first-class structural work is too well known to need discussion, and if "Subscriber" was told that the method described of doctoring up loose rivets is general practice out here in the local shops, he must have made his inquiry to and obtained his information from some improper source. It would not be necessary for an engineer or anyone experienced in construction of this kind to ask you: "Is this a good method or a safe one, and to what extent is the efficiency of the joint impaired?"

"Subscriber's" third query as to whether it is the practice to doctor up rivets in the fashion described in the Eastern structural shops has no place in his general inquiry, on the assumption that the motive of such an inquiry would be in the interest of education.

The circumstances upon which "Subscriber's" communication to you is apparently based occurred in connection with the following: An order was placed with a local shop for two columns to be made up of angles and plates riveted; there were no specifications furnished and the understanding in taking the work was that it was to be ordinary structural work with punched holes. The holes throughout were punched with a standard 13-16-in. punch for ¾-in. rivets, and all of the holes were exactly 13-16-in. diameter on the "punch side"; on the "die side" the holes were naturally larger (which your correspondent does not appear to understand), but in the thicker members did not exceed 15-16-in. diameter. The plates and angles when assembled had the holes evenly matched.

Upon completion of the columns an inspector found some rivets loose after a hammer test, such loose rivets were found with two exceptions where the combined thickness of the various members was extraordinary. Examination of the faulty rivets indicated that such rivets had not been sufficiently driven, and they were consequently driven more and were driven so well that the most severe hammer test applied by the inspector and others interested failed to disclose any looseness whatever. No rivet was "tightened" with cold chisel as indicated by "Subscriber." Had they been so the slightest hammering would have restored the looseness. On this point the inspector himself agreed. The fact is, the rivets were efficiently driven and were equal when finished to the best work of that class, East or West.

The statement in the last paragraph of "Subscriber's" communication in regard to the superintendent of the shop had no place in his communication to you. Whatever discussion there was between the superintendent and the other interested parties was confined to the business transactions involved. It was for the purchaser and inspector to accept or reject the work.

After a most careful examination and rigid tests of all the rivets in the columns, the columns were accepted as satisfactory by all parties concerned on the side of the purchaser, notwithstanding certain objections remaining on the part of the inspector which by that time had become mere personal criticisms, and which were overruled by the chief, the architect of the work, and also by disinterested engineers of established reputation whose qualifications cannot be questioned.

Your comments on the subject brought up in "Subscriber's" communication, I have also read with interest, and I believe they cover the question properly, but you give no information that is not well known to the shops in Seattle. For the benefit of such persons we trust that further comment by your readers will not be lacking.

In conclusion, I would state that I am also a subscriber to the Engineering News, but I would not take advantage of that fact at any time to make use of your paper for the purpose of renewing a discussion which occurred in connection with a business transaction, and which was brought to a satisfactory conclusion. Being familiar with the facts as above stated I cannot let the matter pass without a correction. I do this in a spirit of fairness and justice to the shops of Seattle.

Finally, I would state that had "subscriber" been a reader of the Engineering News for as long a period as I have he would not find it necessary to refer such questions as taken up in his communication of September 23 to a publication such as yours; he would have long since acquired information that would enable him to confidently decide such questions himself.

Thanking you in advance for your attention and space, I remain,

Respectfully,

A. Y. Bouillon.

515 Tenth Ave., Seattle, Wash., Oct. 12, 1905.

(We give space with pleasure to the above letter, but must in fairness defend our correspondent "Subscriber." His communication, published in

our issue of Oct. 5, was wholly impersonal, mentioned no names, and raised an entirely fair question of general interest to the engineering profession as to what constitutes good workmanship in riveted work. It is undoubtedly true, as Mr. Boulion states, that many experienced engineers know what good workmanship requires; but there are, on the other hand, many in the profession who are just gaining experience and who will be benefited and helped by just such opinions from practical engineers as those which "Subscriber's" inquiry has drawn out, and which have been published in our issues of Oct. 12 and 19. It is, we believe, one of the chief opportunities for usefulness of such a journal as Engineering News to give an opportunity for the fair and open discussion of just such practical questions of every-day work in the shop, the field and the office as this one brought forward by "Subscriber." The fact that the question was settled in the specific instance referred to between the architect and the contractor detracts nothing at all from the interest of the question itself; and "Subscriber" was not only entirely within his rights in forwarding us the question for publication, but in doing so rendered a service to the engineering profession.

We have thought it proper to emphasize this matter, not so much for the sake of defending our correspondent "Subscriber" as to make clear the fact that such practical inquiries as his are welcomed by us; and that no engineer should be dissuaded from submitting such questions for discussion by his professional brethren, merely because the question has been, in a particular case, already decided.

And now, to take up the specific question at issue, Mr. Bouillon's letter says:

> Examination of the faulty rivets indicated that such rivets had not been sufficiently driven, and they were consequently driven more and were driven so well that the most severe hammer test applied by the inspector and others interested failed to disclose any looseness whatever. No rivets were "tightened" with cold chisel as indicated by "Subscriber." Had they been so the slightest hammering would have restored the looseness. The fact is the rivets were efficiently driven and were equal when finished to the best work of that class, East or West.

Unless we misunderstand the above statement the rivets were found loose when cold, and were then "driven more." Whether this driving of the cold rivets was done with a power-riveter, a pneumatic hammer or a hand sledge is not stated; but in our opinion any such cold working of rivets, while it would doubtless make them tight to the testing hammer would not make them anything like equal in strength to rivets properly driven in the first place. Such work on cold rivets is expended chiefly on the heads, the shank is not upset by it, and the heads are liable to be so injured by the cold working that they will be brittle and fly off if the joint is put under stress. As several correspondents have explicitly stated, the only proper thing to do to a loose rivet is to cut it out and drive a new one.—Ed.)

Notes and Queries.

H. M. P. writes:

> Kindly advise me the official rule as to the right or left bank and fork of a stream, whether you designate it going up or coming down?

It is our impression that the right bank is the one on the right when facing down stream; but we can quote no authority and shall be pleased to hear from any reader who may be able to do so.

SOME POINTS IN BRIDGE CONSTRUCTION AND MAINTENANCE.

The committee on Steel Bridges which reported to the Association of Railway Superintendents of Bridges and Buildings at the Pittsburg convention, a week ago, presented as its report a summary of practice in several specific matters of bridge design, construction, and maintenance, which should be of interest outside the limits of that association. The committee comprised the following: H. H. Eggleston, Central Indiana Ry., Anderson, Ind., chairman; J. P. Snow, Boston & Maine R. R., Boston, Mass.; C. H. Cartlidge, Chicago, Burlington & Quincy Ry., Chicago, Ill.; H. M. Trippe, Chicago & Northwestern Ry., Chicago, Ill.; and J. W. Lantry, New York Central & Hudson River R. R., Weehawken, N. J. It was intended to draw up a summary based on the practice of all the important railways of the country, but the small proportion of replies makes the report represent only a limited range of roads.

The report, together with additional remarks contributed by several members, is here reprinted in slightly condensed form:

METHODS OF ERECTING BRIDGES.

Travelers are used to some extent for erecting truss spans, but where available derrick-cars are used instead. One writer claims that where the use of travelers can be avoided trusses are erected as cheaply as girders. Derrick cars are preferred for handling material. Wrecking cranes are occasionally used for setting girders. Girder bridges are frequently, and truss spans occasionally, erected to one side of the site and shifted over into place between trains. Trusses are more often erected in place and the floor shifted between trains; this method is sometimes used also for girders. For heavy traffic a temporary track around the bridge site is sometimes convenient. Gallows frames may often be used advantageously for heavy girder work, and sometimes pile drivers are useful to handle one end of a deck girder bridge riveted up complete. Practice seems to tend toward the use of derrick cars built expressly for road department work.

Costs of erection are quoted as $4 to $10 per ton for girders, and $10 to $20 per ton for truss work, not including transportation.

The larger railway systems generally erect all bridges with their own men. Some roads favor contractors for large jobs and road forces for girders and small structures. Very few of the replies received favor contractors for all bridges. There is no difficulty in having outside parties erect bridges and care for falsework under traffic, and the question therefore resolves itself into one of economy. Where bridge erection work can be made fairly continuous on a given road, the railway forces can do it cheapest; where but little erection work is done the larger jobs should be contracted. There are enough independent firms making a specialty of erection to enable contracts to be let separately for fabrication and for erection.

> Mr. R. H. Reid: On the Lake Shore plate girders are usually put in place with steam derricks, at a cost of from $4 to $6 per ton; truss bridges are built on falsework, using travelers to erect the upper parts of large trusses. We erect all our structures and much prefer that method.

RIVETING.

The committee finds general sentiment in favor of pneumatic field riveting, only one reply expressing preference for hand-driving. However, as small jobs (and sometimes large ones, due to an insufficient number of air plants) are riveted by hand, all work should be designed on the basis of hand driving of field rivets.

CLEANING AND PROTECTING FROM CORROSION.

Cleaning by hand (scraper and wire brush) is by far the most common. Some of the roads replying have used the sand blast and think it practically indispensable where the steel is badly scaled and pitted, in which case hand cleaning is ineffective to give a good base for durable painting; the sand blast is admitted to be expensive. One reply reports the successful use of strong lye for cleaning steel for painting. In the matter of when and how to paint, the language of the report is excellent:

> Where ordinary weather rust occurs it can be kept under control by ordinary cleaning and painting, if in about a year after the work is done it is gone over and the spots which show rust a second time are touched up. Certain exposed parts of a structure become rusted before others, of course; and if these parts were repainted two or three times to the other parts once, economy would result. Painters, however, dislike to paint by patchwork, and the result is that the exposed parts are allowed to get beyond control before it is decided to paint the structure as a whole.
>
> As to kinds of paint used, no two replies agree. Several are experimenting with hopes of learning something valuable. It is pretty well ascertained that no one kind of paint is the best for all conditions. Asphaltum paints are much better in sheltered places than in the sun. Linseed oil paints are much better in the sun than in dampness. Inert pigments in gum vehicles are better where exposed to engine gases than metallic pigments. An absorbent of moisture is a desideratum for a priming coat. It will be admitted that it is asking much of film of paint only one one-hundredth of an inch thick to protect a material so readily oxidizable as our open-hearth oxygen-filled steel from the corrosive action of engine gases, brine and the weather for a term of years. [illegible] that the final word has not been written yet [illegible] question.

CORROSION OF FLOORS FROM REFRIGERATOR-CAR BRINE.

Much trouble is reported, by roads having a large traffic of refrigerator cars, from corrosion of floor beams and stringers by brine drippings. Frequent cleaning and painting is the most common means of combating the trouble. Mr. R. H. Reid, L. S. & M. S. Ry., writes:

> Our experience in this line has been very [illegible] as we handle a great many refrigerator cars, and, [illegible] east bound tracks especially, the corrosion has been serious, in many cases causing the renewal or repairs of floor systems and girder bridges. The dripping of salt brine from cars is one of the most important that confronts American railroads, and [illegible] the most vigorous treatment for the prevention of [illegible] dripping.

A protective treatment is reported by Mr. C. P. Loweth, C. M. & St. P. Ry., thus:

> I have lately been covering the tops of stringers and beams with a cotton ducking saturated in a preparation of linoxyn and a resinous flux. This prepared canvas is ironed hot on to the steel surface and adheres more or less perfectly, and I hope to get good results from it; but have not had it in service long enough to say positively. This preparation is called "iron bark," and is manufactured by the Edward Smith Co., New York.

The Burlington uses other means, described by Mr. C. H. Cartlidge as follows:

> We find that a concrete deck with ballast is an absolute preventative of trouble, and are employing that wherever possible. On bridges where a concrete deck cannot be used, we are having good success with felt roofing; cutting it into strips slightly wider than the flanges of the stringers and placing it there and underneath the ties, first painting the iron with the compound used with the roofing.

SPACING OF STRINGERS.

The report states that spacings of 5 ft. to 8 ft. are reported; but while none recommend a wider spacing than their standard, some would prefer a narrower spacing than used on their road. Some are using four stringers with satisfaction; others urge the doubtful load-distribution with multiple stringers. With multiple stringers the spacing varies as much as with but two; the extremes are 2 ft. 6 ins. for all center distances of four stringers, placing each rail midway between a pair, and four stringers at 5 ft. center distances, where the inner ones carry the regular load and the outer ones (on a lower factor of safety) carry load only in case of derailment. The committee thinks that the great diversity of practice indicates need for full compilation of practice and a further study of the subject to arrive at a conclusion as to what arrangement is best.

Mr. J. T. Carpenter, Southern Ry., says:

> Our steel viaducts are . . . spaced 7 ft. and 10 ft. and in one case as much as 11 ft. centers. I think 10 ft. and 11 ft. centers too much, as we do not get the life of the timber in the cross-ties that we do at 7 ft. centers.

Mr. R. H. Reid gives 6 ft. 6 ins., single stringers as standard on the Lake Shore, and suggests that double stringers centered under the rails will require more metal in stringers and, as the moment arm is longer than with single stringers at 6 ft. 6 ins. spacing, also more metal in the floor beams. The most positive stand is taken by Mr. J. P. Snow, B. & M. R. R., who says:

> I prefer main stringers 5 ft. center to center with side stringers 10 ft. center to center. Our standard ties are 12 ft. long and any other arrangement of stringers does not give satisfactory support. With this spacing we are enabled to use ties 7 ins. deep by 8 ins. wide. These are notched to 6½ ins., which is enough to receive the spikes. The legitimate function of a tie is to hold the rail to gage and line; it ought not to be asked to act as a beam to assist the iron floor of a bridge, which is what it is required to do if the stringers are spaced wider than 5 ft. on centers. I admit that it saves in first cost to use a large tie and less iron, because timber is cheaper than iron wherever it is applicable. By the same token the entire bridge, if it is not over say 150 ft. span, can be built cheaper in wood than in metal; but if we are building an iron bridge I think we should make all of its supporting parts of iron and leave the ties to their normal function.
>
> Our side stringers are about one-half the strength of the main stringers, so that they will safely carry the trains if off the rails. Their spacing is such that the ties overhang enough at each end to bring the guard timber bolts clear of the iron, but not enough so that the tie can break off or tip up if a wheel is on the end of it.
>
> If the main stringers are spaced more than 5 ft. apart, larger ties than those above described are needed; they must act as beams; and, as the maximum bending moment obtains under the rail where the tie is subject to injury by the spikes and cutting by the rails, they must be renewed at shorter intervals than if they act simply to support the rail directly over the stringers. The side stringers add to the rigidity of the floor and their cost is partly recovered by the smaller size and longer life of the ties.
>
> In the case of deck plate girder bridges, we set the girders 9 ft. on centers and put in cross floor beams with stringers 5 ft. on centers, the tops of the stringers being flush with the tops of the girders, thereby giving four

supports to the ties. These girders, up to 65 ft. long, are shipped to us riveted up complete; and they are more easily put in place than single girders. The additional cost of the floor is not so much as would be thought at first sight, as the floor beams constitute a large part of the building. The extra cost of the floor is equal approximately to two suits of ties. By this construction the top flanges of the girders are relieved from the direct action of the wheel loads and are left to their legitimate function of compression only. Many old plate girders show distress by the top angles working on the web from the pounding of the wheels. It is, in fact, the only way in which I have ever known a plate girder to fail. The above construction remedies this trouble and should, I think, be given more consideration than it has heretofore received.

The significant thing about the report is the complaint of several members of too wide spacing on their lines. Now these complaints are by men who deal with the actual business of caring for bridges, not by engineers theorizing about economy or the elastic advantages of a spring tie; and I think the complaint should be heeded. If there is any sound reason why the supporting stringer should be removed to a distance from under the rail, which it is its only duty to support, and the rapidly decaying wooden tie be called upon to help out the iron floor beam, I should like to have such reason explained to me.

FINISHING ENDS OF STRINGERS SQUARE TO TRACK.

The committee reports replies unanimous in favor of the practice of ending the two stringers of a track on a line square to the track, the object of such arrangement being to avoid all chance of rolling motion set up in the train as it strikes the bridge. The committee suggests that the girders of a deck plate girder bridge should be similarly squared, although this is frequently not done (the same is the case with stringers).

PIN-CONNECTED VS. RIVETED TRUSSES.

Preference seems to be indicated for riveted trusses, doubtless only up to a certain limiting length; some would place this limit at 130 to 160 ft. It appears that practice is tending toward the larger use of riveted trusses, and for ever longer spans.

The committee received report of some trouble from the wearing of eye-bars on pins. One reply called for pins long enough in the thread to take a cotter-pin outside of the nut.

SUPERELEVATION ON CURVES.

Of fifteen replies five favor putting the superelevation in the ties, eight favor putting it in the stringers, and two use longitudinal raising strips under the ties. One reply favors tilting the spans when under 50 ft. long.

BREAKAGE OF BRIDGE-SEAT STONE.

Some trouble is reported from the breakage of limestone bridge seats, especially when imperfectly bedded. In one case trouble was experienced from tearing out of the anchor-bolts of the stringer ends, due to temperature changes. No trouble is reported with sandstone, granite or concrete bridge seats.

COST OF THE CHICAGO DRAINAGE CANAL.

At the last session of the Illinois legislature, the Chicago Sanitary District was called upon to submit a complete report of its receipts and expenditures, and this report has now been presented to Governor Deneen. It gives itemized accounts of the receipts and expenditures from the date of organization of the District (Jan. 18, 1890), to July 1, 1905. The report shows that the year 1900 yielded the largest receipts, $8,869,161, while the expenditures were $7,066,154. In 1901 the receipts sank to $1,344,805 and the expenditures were $2,997,873, but in 1902 the receipts from bonds was increased to $4,978,003 and the expenditures were $3,742,239. Bonds to the amount of $1,000,000 were retired that year. The first six months of 1905 show receipts of $1,864,465 and expenditures of $1,597,876. The general summary of receipts and expenditures is as follows:

RECEIPTS.

Taxes collected for general purposes	$30,036,223
Taxes collected for development of water power	1,662,536
Bond account	16,135,000
Dock and land improvement and rental account	34,453
Tax levy, 1896, warrants outstanding	5,212
Interest on deposits	353,646
Total receipts	$48,227,073

EXPENDITURES.

Right of way	$5,362,390
Desplaines River diversion and bridges	1,142,672
Main channel, including bridges	20,490,014
Controlling works, including bridge	339,127
Joliet project, including bridges	1,580,414
Maintaining Summit level	167,404
Improving dams in Illinois River	9,520
Raising roadway of Brandon's bridge	4,413
Water power development, including bridges	854,441
Bridge maintenance	573,845
Interest charges	6,955,479
Improving Chicago River, including bridges	4,284,681
Thirty-ninth St. pumping station	211,604
Telephone line	12,147
State inspection of main channel	33,045
Taxes on land in Cook County	3,150
Taxes on land in Du Page County	1,200
Taxes on land in Will County	27,310
Personal injuries account	4,087
Marine damages	9,647
Land damages	76,331
Administration expenses:	
Engineering department	$2,008,405.06
Clerical department	167,204.16
Law department	981,084.18
Treasury department	39,637.34
Police department	389,011.84
General account	839,309.94
Total cost of administration	4,424,652
City of Chicago	13,824
Weir, McKechney & Co.	22,118
Streeter & Kennefick	5,020
E. D. Smith & Co.	2,400
Total expenditures	$46,610,992
Emergency funds in hands of:	
Isham Randolph, chief engineer	$4,500
S. D. Griffin, clerk	18,000
James Todd, attorney	2,000
Seymour Jones, att'y	300
Balance in hands of treasurer June 30, 1905	1,591,281
	$1,616,081
Total expenditures and balance	$48,227,073

The following table shows the receipts and expenditures by years:

	Receipts.	Expenditures.
1890	$75,100	$68,362
1891	989,897	267,882
1892	2,077,164	961,831
1893	2,239,624	3,888,427
1894	7,399,367	6,292,134
1895	6,537,808	7,400,752
1896	8,172,768	8,490,423
1897	6,619,008	6,449,312
1898	5,610,972	5,877,834
1899	6,463,237	6,482,049
1900	8,869,161	7,066,154
1901	1,344,805	2,997,873
1902	4,978,003	3,742,239
1903	3,507,380	3,945,769
1904	4,348,857	3,976,485
1905 (to June 30)	1,864,465	1,597,876

THE LONG-DISTANCE ELECTRIC TRANSMISSION plant of the Nevada Power, Mining & Milling Co., near Bishop, Inyo County, Cal., described in Engineering News of July 6, was started in operation on Sept. 17. Current is now being transmitted over 113 miles of three-phase aluminum cable to Tonopah and Goldfield, Nevada. The transmission line and all the transformers worked perfectly from the start. For no purpose whatever has there been a shut down for a moment of any of the machinery.

THE COMPLETION OF THE SECOND HUDSON RIVER TUNNEL.

In our issue of Oct. 5 we noted the completion of the south, or second, tunnel of the New York & Jersey R. R. Co.; extending under the Hudson River from Jersey City to the New York shore near Morton St.

The photograph here reproduced shows the bulkhead wall built in 1882, when work was abandoned on the short stretch of tunnel constructed from the New York end. Part of the base of the shaft is seen connecting the two tunnels at this end. This 30-ft. section of old tunnel was fairly struck by the south tunnel carred under the entire river bed, from the New Jersey shore, a distance of about 5,100 ft., of new work. As before mentioned, the Chief Engineer of this tunnel is Mr. Charles M. Jacobs, also Chief Engineer of the Hudson Companies, which is exploiting other tunnels under the Hudson River and under the New Jersey shore of this river.

"HOLING" THE SOUTH TUNNEL OF THE NEW YORK & JERSEY R. R. CO. UNDER THE HUDSON RIVER. VIEW OF THE EAST SIDE OF THE BULKHEAD WALL AS BROKEN THROUGH TO THE NEW YORK SHAFT ON SEPT. 29, 1905.

RECONSTRUCTION OF VIADUCT FOUNDATIONS WITH CONCRETE PILES; NORFOLK & WESTERN RY.

The use of concrete piles to reinforce the foundations of an existing viaduct without interruption to traffic is an interesting and important piece of work now in progress on the Norfolk & Western Ry. This railway has at Kenova, Va., a steel viaduct which forms the eastern approach to the bridge across the Ohio River at that point. The viaduct is 2,208 ft. long, and is composed of 70 spans of 30 ft. 8¼ ins. each, and one span of 60 ft. crossing the Chesapeake & Ohio Ry. The soil on which it is built is clay, with a slight admixture of sand. When dry the material is hard, but when wet it is very soft, and the latter condition exists during the major portion of the year. For a few months during the summer it dries out and becomes quite firm.

The large increase in traffic during the past few years, and the great weight of the new rolling stock used on this line, have caused a settlement of most of the small footings under the pedestals, with the result that many of them have cracked and gone to pieces, making necessary considerable expense for repairs and in surfacing and lining

the track. As the increasing traffic indicated the necessity for double tracking the viaduct at an early date, and the condition of the footings steadily grew worse, it became evident that these footings would have to be replaced by something more substantial.

The new footings were designed to carry a load of 325,000 lbs. each, and the original plan was to use 12 creosoted piles surmounted by a concrete

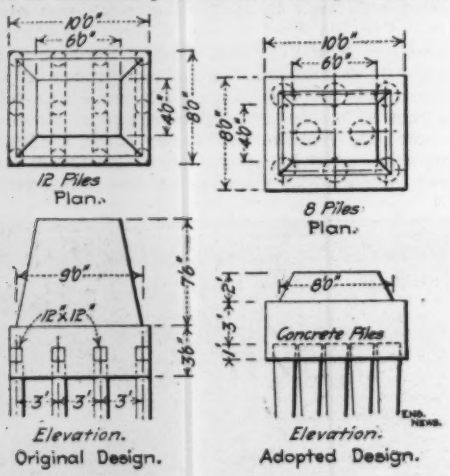


Fig. 1. Original and Adopted Designs for New Footings of Kenova Viaduct; Norfolk & Western Ry.

(Original design with creosoted wooden piles. Adopted design with Raymond concrete piles.)

pedestal, as shown at the left in Fig. 1. After making these plans it was thought that perhaps a better and more economical construction could be secured by using concrete piles in place of the creosoted piles and caps. The use of concrete piles was, therefore, carefully investigated by the engineering department of the Norfolk & Western Ry., and by the E. G. Nave Bros. Co., of Portsmouth, O., which was the lowest bidder on the original plan. As a result of this investigation, it was decided to use concrete piles on the Raymond system, as controlled by the Raymond Concrete Pile Co., of Chicago. The adopted design is shown at the right of Fig. 1, and the comparative estimates of the average cost of each footing under the original and adopted designs are given below:

Original Design (Timber Piles).	
31 cu. yds. excavation, at 50 cts.	$15.50
22 cu. yds. P. cem. concrete, at $6.50	143.00
348 ft. B. M. creosoted timber, at $45	17.28
240 ft. creosoted piles, at 56 cts.	134.40
55 lbs. iron, at 6 cts.	3.30
Total	$313.48
Adopted Design (Concrete Piles).	
20 cu. yds. excavation, at 50 cts.	$10.00
14 cu. yds. P. cem. concrete, at $6.50	91.00
8 concrete piles, at $22	176.00
Total	$277.00
Estimated saving on each footing	$36.48

The saving was effected by reason of the fact that, owing to the large size and great taper of these concrete piles (20 ft. long, 20 ins. diameter at the top and 6 ins. at the bottom) a smaller number could be used to secure the necessary bearing, and the amount of excavation and concrete in the cap could be materially reduced. This construction has the added advantage of employing only material of unquestioned durability in soil alternately wet and dry.

The Raymond system of concrete piling has been described in Engineering News of June 20, 1901; Dec. 11, 1902, and March 26, 1903. It consists in driving a sheet metal shell or casing by means of a collapsible steel pile core. When the core is withdrawn, the shell or form remains in the ground and acts as a mold for the concrete and prevents the soil from mixing with the concrete. A turntable pile driver, with leaders 38 ft. long, was built specially for this work. A Vulcan steam hammer is used, and from 300 to 600 blows are required to drive the piles, which are 20 ft. in length. The shell is placed on the core, pile driven, core pulled, and shell filled (completing the pile) in about 20 minutes.

The steel bents have of course to be removed, and a certain portion of the structure is temporarily supported by a timber trestle whose bents alternate with those of the steel viaduct. The timber bents are braced to form towers 14 ft. 8¼ ins. between the legs, with a maximum span of 16 ft. between the legs of adjacent towers, where space is left without bracing to give room for the pile driver. There are 16 of these bents, with two plumb posts and two batter posts 12 x 12 ins., and mud sills composed of two timbers 6 x 12 ins. The batter is 3 in 12. Over each open span is a truss formed of a 10 x 14-in. bottom timber, 14 x 14-in. top timber, short posts 12 x 12 ins. over the bent posts, and diagonal braces 3 x 12 ins. This trestling and the special pile driver are shown in Fig. 2. The work is now in successful operation, and owing to delay caused by removing and replacing the iron work and maintaining traffic, will not be finished for some time.

The work is being done by the E. G. Nave Bros. Co., of Portsmouth, O., and is under the general supervision of Mr. Chas. S. Churchill, M. Am. Soc. C. E., Chief Engineer of the Norfolk & Western Ry.

CONDITIONS AT PANAMA AS SEEN BY A MEMBER OF THE CONSULTING BOARD OF ENGINEERS.

We have been favored with permission to publish a letter written by Mr. Isham Randolph of the Consulting Board of Engineers, to Hon. Zina R. Carter, President of the Sanitary District of Chicago, describing the conditions on the Isthmus as seen by Mr. Randolph during the recent visit of the Board to the Isthmus. Mr. Randolph's letter, which is dated Oct. 23, treats of topics of such general interest to engineers and contractors that we print it in full as follows:

Dear Mr. Carter:

As you share in the widespread interest which attaches to the Panama Canal I will tell you some things which I feel sure you will be pleased to hear. For the Commercial World that interest attaches to it as a needed highway for marine commerce; and thence we hear the pressing question: "How soon will it serve the purpose for which it was conceived?" There is no authority short of omniscience competent to answer that question with certainty, and from that high source the answer has not been vouchsafed. What we do not know is that it can be done; that Americans can do it; and do it in as short a time as so stupendous an undertaking can be put through. We do know that almost limitless resources await the demand of the builders; that the builders represent the highest grade of American engineering talent, led on by a man whose record of accomplishment is "but the earnest of the things that he shall do." Hence we may reasonably look for the passage of the great ocean freighters from the Caribbean to the Pacific before our calendars are headed 1915. How much before, this deponent sayeth not.

This will be no easy triumph for the builders, who must contend with and overcome difficulties not [illegible] in our temperate zone. First there are clim[illegible] ties, which, however, my investigations for[illegible] believe have been magnified; exaggerated. [illegible] learned through correspondence and person[illegible] with the men who are doing the engineer[illegible] who hail from various parts of our union a[illegible] are backed by the fact that they have endure[illegible] for periods of from nine to fifteen months [illegible] ness or any other disability resulting there[illegible] dent foresight on the part of the authoritie[illegible] men vacations at intervals of twelve months [illegible] transportation back to the invigorating clim[illegible] land from which they came. I journeyed wi[illegible] these men and found them returning to the[illegible] high health and with that devotion to duty [illegible] distinguishing characteristic of the American [illegible] I met many on the Isthmus and no word of d[illegible] ment escaped them. As to the dread scourge [illegible] fever: during the time of my stay there was b[illegible] on the Zone, and when death ensued in that [illegible] was not another left behind. I give the offi[illegible] for the following months: June, 62; July, 4[illegible] 27; September, 6; October, 0.

The luxuries and many of the comforts of life are missing from the allottment of these men, and of this I heard so much complaint that I caused a letter to be written to one of my former assistants months ago. In reply he said that these complaints did not come from the engineers who were used to doing the frontier, pioneer work of our country; but from men who went anticipating conditions no better and no worse than those with which they had contended in the temperate zone; and it was even as they expected. I mingled with the white men who are there in minor positions of trust and to one of these I remarked that I was pleased to find that much that I had read in the States about discontent and discomfort seemed to be exaggerated. He said that a large proportion of these adverse reports were due to the fact that the men who came down there were not properly advised as to what they had to meet or how they should be equipped for living, and that for a time the facilities for housing the men were altogether inadequate. They would arrive without proper equipment and no place to get what was needed save from the Chinese shop keepers, who did not neglect any opportunity for extortion. Then he said for a time there were no fixed quarters assigned. "The American you know is a creature who likes to gather little home comforts of his own about him; he likes his own nail on which to hang his coat; his own corner shelf on which he can place his Bible or his whiskey bottle, to whichever of these he most inclines, and he resents it when he is told to move on and relinquish those comforts to others." The question of proper housing has been a problem, but its solution is progressive, and it has had to wait upon lumber which must come from the States. This lumber is arriving. I saw in the Bay of Panama two great ocean freighters laden with cargoes of the much needed lumber, which was being unloaded on to lighters and taken to the railroad for distribution. This was in square logs which are sawn, at a mill provided for that purpose, into the thickness needed for the work.

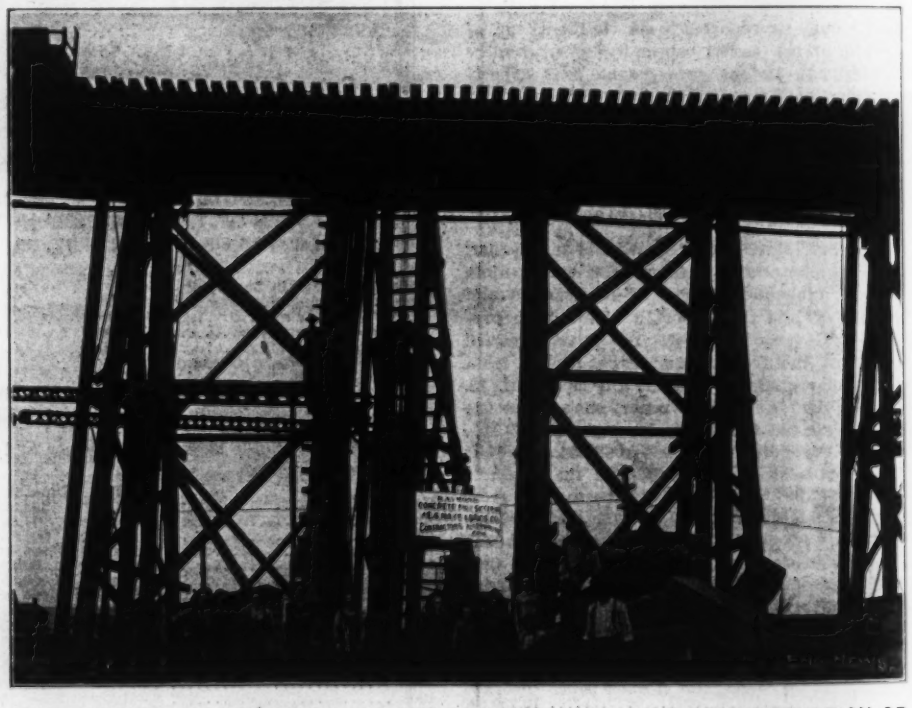


FIG. 2. TEMPORARY TRESTLE USED TO CARRY VIADUCT DURING RECONSTRUCTION OF FOOTINGS.

The French left behind them some 2,500 buildings, little and big, which are being made habitable, but many more must be built to house the thousands whose labors are required to accomplish the work. When the equipment is on hand and the organization perfected, at least 24,000 men will be required in the various departments of industry. The source of supply for labor so far has been Jamaica. The efficiency of this labor is low, as low as 25%, taking an average laborer in our latitude as the unit. This is due in part to the fact that the supply is not now equal to the demand, and an independence is thereby induced which tends to worthlessness. There is no pressure which can be applied to those people which will make them do their best under existing conditions. If a foreman undertakes to make them do a fair day's work, they quit and move on to the next camp where they know that a job awaits them. It is reasonable to believe that this condition will improve when the importation of laborers becomes somewhat in excess of the demand. Then a job will be at a premium, whereas now it is at a discount. I was told by white men on the work that the Martinique negroes were superior to those from Jamaica in their working qualities. The introduction of the eight-hour system on the Isthmus seems a lamentable mistake and one which adds about 25% to the labor cost of the work.

The whole line is cluttered up with abandoned French machinery, the cost value of which is said to reach $30,000,000. This machinery is valueless, out of date, and the efforts to use it have proven disastrous because had it been recognized in the beginning that better appliances must supercede the devices which were modern twenty odd years ago orders would then have been placed for the best machines of our day and they would have been arriving now in such quantities as the needs of the work call for. I cast no reflections upon the work of the French, they left behind them evidence of engineering skill and successful battle with difficulties which convinced me that if the honest workers had been sustained and the vast sums which were diverted into robber channels had been legitimately applied, it might to-day be the mission of the United States only to enlarge the Panama Canal which would have become inadequate for the traffic seeking it, because ships have grown beyond any gift of prophecy possessed by seers of that day.

Much has been said pro and con about doing this work by contract. This is a question of policy about which I hold very positive views, but inasmuch as there has been no call for my opinions relating thereto I refrain from giving expression to my convictions.

As to the feeding of the men: On my last day in Panama, after hours of tramping in the rain through the mud of the Culebra Cut and laborious climbing up the jungle clad hills, I arrived with two others of our party at a Government hash house. We went in unannounced and ordered dinner. There was no delay in serving and there was a reasonable variety of well-cooked, wholesome food, better than I have found in 75% of the many contractors' camps in which I have eaten in the last 37 years. The charge for this board is 25 cts. per meal or $22.50 per month.

The rainy season was still prevailing during our stay and the precipitation is enormous. The records covering 33 years show an average annual rainfall of 128 ins. at Colon, 146 ins. at Bohio, dropping to 66.8 ins. at Panama. The averages for the two last named places are respectively for 7 years at Bohio and 4 years at Panama. On the day that we called on President Amador of the Republic of Panama, the windows of heaven seemed to have been opened and the streets of the city resembled mountain torrents.

The hospitals are a source of just pride to our people. If sickness could ever be regarded as a boon, it may be so thought of in Ancon and Colon. One of the privileges of our trip was meeting Col. Gorgas, whose work as Medical Director places him in the front rank of that noble profession which honors him for the honor he has won for it. In Colon I met a son of the first friend that I ever made in Chicago a way back in 1872. He is one of the staff of physicians in the Colon Hospital, happy and enthusiastic in his work.

You will no doubt have seen statements which purport to have come from members of our Board of Consulting Engineers foreshadowing our report, all such statements you can set down as the manufacture of newsmongers. We are working earnestly and laboriously to reach conclusions which embody the fruits of our labors. Our report—or our reports, should we fail to agree—will embody our convictions as to the best type of canal, its probable cost and the reasonable time within which we believe that the waterway can be constructed. Until we are ready to make our official statement and sign our names to it, we are not giving out individual statements relating to any of the fundamentals of the project, to have them find their way into the press through personal friends (?) who would make capital of our confidence.

Yours sincerely, Isham Randolph.

THE SECOND LARGEST STONE ARCH BRIDGE in the world, a railway bridge at Salcano, Austria, was recently completed. The arch has a span of 85 m. (279 ft.).

THE USE OF ALUMINUM TO REDUCE SEGREGATION IN STEEL INGOTS.

The use of aluminum in the steel foundry to quiet the metal and reduce the tendency to blowholes in the castings is, we believe, common practice in casting steel. The addition of aluminum to steel in the ingot, however, to lessen segregation is a matter on which comparatively little authentic information exists. In a paper read at the recent meeting of the Iron and Steel Institute, Mr. B. Talbot, well-known to American metallurgical engineers, read a paper in which he recounted extensive experiments to determine whether aluminum actually did act to reduce segregation. Ingots of both acid and basic steel were cast with and without aluminum and specimens for chemical analysis were taken at a dozen points in the height of the ingot and at various points in its cross-section. As a rule, the results showed that in the ingots cast without aluminum, excessive segregation down the central line of the ingot occurred from a point about 6 ins. from the top to about half way down the ingot. The tendency to segregation is greatest for sulphur and then follows phosphorus, carbon and manganese in the order named. Comparison of the ingot cast with the addition of aluminum showed a much smaller amount of segregation.

We quote further from Mr. Talbot's paper as follows:

No comparative tests were made in the case of basic steel with and without the addition of aluminum. As it became the established custom at the works always to ad da small amount of aluminum to all ingots, the author at the time did not consider it important to have this done, considering that the influence of a small amount of aluminum in decreasing the area of segregation had been already sufficiently proved.

In order to prove the importance of leaving the ingot always in a perfectly upright position, until time has been given sufficient to allow the center to solidify, an ingot was taken immediately after being cast, and while its center was still quite fluid, and inverted so that the base stood uppermost. After cooling in this position, the ingot was cut open, and analyzed. As was to to be expected, the most segregated portion was here found in the end which had been allowed to cool uppermost; that is, the broad end of the ingot, although this was the original bottom end. The ingot from the same cast, which was not inverted, has, of course, the segregated area in the normal position.

Another point to which attention should be drawn is that fairly high carbon basic steel, made from a phosphoric mixture, and in which the carbon has been raised from dead soft to about 0.5%, showed a great regularity in the percentages of carbon, obtained by the addition of solid carbon to the steel while running into the ladle. Continental writers have several times lately questioned whether sufficient regularity can be obtained by this means, and the author draws special attention to these analyses of carbon, as he considers they show the groundless nature of these statements.

An examination of the foregoing results shows clearly that by the use of aluminum a billet of a much more regular composition is obtained. This is especially important in the case of carbon, especially if this steel had without aluminum been intended for rail purposes, as the surface of the rail would probably have shown considerable irregularities in the carbon percentage, with a consequent want of uniformity in its wearing properties.

In cases in which the carbon has segregated to the center, it is obvious that corresponding areas will be found at the sides in which the carbon is less than the mean, through the carbon having migrated to the center to a greater or less extent.

In cases in which aluminum has been added the segregation is lessened, the distribution of the carbon over the surface of the ingot is found to be much more even, and to approach more nearly to the composition given by the ladle test.

So far as the author is aware, Pourcel was the first to point out that the addition of aluminum gives homogeneity to the steel. The analyses given in the tables certainly tend to confirm this view. The reason why this should be so seems somewhat obscure, and the author does not wish to put forward any view on the subject by way of explanation, but the following considerations may serve to throw some light on the question.

His experience on the addition of aluminum in the ingot mold during casting has always been that the aluminum appears to make the metal set quicker. This, he is aware, is against the view usually held by metallurgists. Thus, in Mr. Harbord's recently published book on steel, it is stated: "The addition of very small amounts of metallic aluminum to such metal" (i. e. metal containing dissolved oxides) "is found to cause a marked increase in the fluidity of the molten metal, to stop the evolution of gas, and to allow of the production of sound ingots without blowholes." Mr. Harbord, however, does not seem entirely satisfied with this view, as on the same page, in referring to Mr. Hadfield's classic work on aluminum steel, he tells us that, according to that investigator, it is doubtful whether aluminum increases the fluidity of properly made steel. This latter view falls in with the facts observed by the author, under whose directions aluminum has been added regularly to many thousands of casts.

Not only does the addition of a little aluminum to the metal as it is run into the ingot have a marked effect in setting the surface, but it also, in the author's experience, tends, when added above a certain quantity, to form cavities in the upper part of the ingot, so that the amount added has to be strictly regulated. The setting effect on the top of the ingot is so marked that at the works with which the author was connected, after it had become the custom to add aluminum regularly, the ingots were never sanded over or stoppered down, as no such treatment was necessary, either with acid or basic open-hearth steel. With mild steel also it was found that the molds could be stripped sooner when aluminum had been added.

It was also observed that when the same quantity of aluminum—viz, some 3 or 4 oz. per ton of steel—was added to the metal as it ran into the ladle, its effect was not so pronounced as when added in the ingot mold as the ingot was being teemed.

There appears, therefore, to be somewhat of a contradiction in the facts observed, some authorities telling us that aluminum in small quantities increases the fluidity of the metal; others, with whom the author joins, contending that the reverse is the case. Theoretically, one would undoubtedly expect some increase in temperature, owing to the reaction between the dissolved oxides in the metal and the aluminum, an action akin to the well-known thermite process.

If an increased temperature is obtained, with the consequent increased fluidity, this would cause the steel to take longer to solidify, and would consequently tend to increase the segregation, provided that the aluminum has no special action of its own on the metal, whereas the numerous analyses made by the author prove that there is a considerable diminution in the amount of segregation. As the metal appears to set quicker, and as, consequently, segregation would be expected to be less, due to this quicker setting, the analyses seem to agree with this view. The author's usual practice was to add about 3 to 4 oz. of aluminum per ton of steel in the ingot, but this was never added until the ingot mold was approximately two-thirds full. Assuming the aluminum to be all concentrated in this top third of the ingot, it would then only be at the rate of about 12 oz. per ton, or about 0.033% aluminum.

In the author's opinion it would be well worth while for other investigators, interested in the manufacture of higher carbon steel, such as for rail, tire, and similar purposes, to follow up these results, with a view of proving whether a more uniform and regular steel is not thereby obtained, a result well worth the few pence per ton the aluminum would cost. Perhaps the chief result to be looked for would be the decreased amount of crop end that it would be necessary to cut off from the top of the ingot, due to the greater solidity of the top and the lessened amount of segregation in this top part of the ingot. This alone would undoubtedly pay for the cost of the aluminum added, without considering the more regular quality of the finished product as a whole.

THE CONSULTING BOARD OF ENGINEERS of the Panama Canal Commission has returned to the United States and its sessions in Washington were resumed on Oct. 19. Two committees have been made up by the commission to study the two types of canal, lock and sea-level, and each to develop the best possible canal of each type suited to conditions on the Isthmus. The committee on lock canals consists of General Davis and Messrs. Guerard, Burr and Hunter; that on the sea-level canal of General Davis and Messrs. Stearns, Ripley and Tincauzer; a third committee on unit prices is made up of General Davis and Messrs. Parsons, Randolph and Welcker. The first two committees will each report to the board and the board will, after careful deliberation, decide between the two types placed before them. It is probable that a conclusion may be reached in two or three weeks. The complete report with maps, plans, etc., will probably not be ready before the last of November.

A PIECE OF PREHISTORIC IRON was analyzed by Mr. H. Braune recently, according to "Stahl und Eisen." The piece was from the upper edge of a water pail found in a prehistoric grave at Castaneda, in southwestern Switzerland; it was covered with thin bronze sheet, which had protected it from rusting away. It contained: 0.14 to 0.18% Carbon, 0.005 to 0.08% Silicon, 0.012% Sulphur, 0.057% Phosphorus, and 0.008% Nitrogen. No manganese, cobalt or nickel were found. The structure was fibrous, but micro-examination showed it quite non-homogeneous, exhibiting very variable carburization. It is concluded that the iron was probably made by Etruscan smiths out of Elba ore.

RAILWAY ACCIDENT STATISTICS, compiled by the Interstate Commerce Commission show for the year ending June 30, 1905, an increase of 11 killed and 4,123 injured among passengers and employees, as compared with the number reported for the year ending June 30, 1904. The increase in the number killed is wholly among passengers, there being a decrease of 106 in the number of employees killed. An increase of 117 in the number of passengers killed makes an increase of 11 in the total killed of both passengers and employees, as above stated. Of the increased number injured 1,963 were passengers and 2,160 were employees. In coupling accidents, which occur wholly to employees, the total number of deaths, 243, is 35 less than for the year preceding, and the number of injuries, 3,441, is 331 less. An advance compilation made from annual reports of railroad companies (which, however, is not complete) indicates that the number of men employed by the railroads on June 30, 1905, was about 9 per cent. greater than on June 30, 1904. During the three months ending June 30 the casualties in train accidents alone were 41 passengers and 221 employees killed, and 1,253 passengers and 1,511 employees injured. Other accidents to passengers and employees, not the result of collisions or derailments, bring the total number of casualties for the quarter up to 14,669 (886 killed and 13,783 injured). A comparison of the figures given in this bulletin with those in the bulletin for the preceding quarter shows a decrease of 637 in the total number of all casualties. The total number of collisions and derailments was 2,766 (1,231 collisions and 1,535 derailments), of which 163 collisions and 168 derailments affected passenger trains. The damage to cars, engines and roadway by these accidents amounted to $2,410,671.

A NEW TRUNNION BASCULE BRIDGE with a single leaf of 150 ft. span over the Cuyahoga River at Cleveland, O., was put into service on Oct. 14. The bridge was designed by Mr. J. B. Strauss, Consulting Engineer, of Chicago, and its general design was described in our issue of Nov. 24, 1904.

PERSONALS.

Mr. Samuel Sutcliffe has resigned his position as Chief of the Bureau of Street Cleaning of Philadelphia, Pa.

Mr. F. H. Shaw has opened an office at 519 Woolworth Bldg., Lancaster, Pa., for the practice of general engineering work.

Capt. Charles H. McKinstry, Corps of Engineers, U. S. Army, has been assigned to duty as Engineer Twelfth Light-House District.

Mr. R. C. Johnson has been appointed Division Engineer, in charge of signals, for the Tidewater R. R., with headquarters at Norfolk, Va.

Mr. L. B. Merriam has been appointed Resident Engineer of the Wyoming Division of the Union Pacific R. R., with headquarters at Cheyenne, Wyo.

Mr. A. J. Rossar has been appointed Resident Engineer of the Canadian Northern Ry., in charge of construction work west of Edmonton, Alberta.

First Lieutenants Harold C. Fisk and Ferdinand Williams, Corps of Engineers, U. S. Army, have been assigned to the Engineer School, Washington Barracks, D. C.

Mr. George H. Blakeley, M. Am. Soc. C. E., Chief Engineer of the Passaic Steel Co., Paterson, N. J., since 1890, has resigned that position, his resignation taking effect Nov. 1.

Mr. John Jervis Vail, Assoc. M. Am. Soc. C. E., and Miss Evelyn Baumann were married Oct. 19 at Rahway, N. J. Mr. Vail is a civil engineer in the employ of the Pennsylvania R. R.

Mr. J. R C. Renshaw, heretofore Supervisor of the New York Division of the Philadelphia & Reading Ry., has been appointed Engineer of the new Harrisburg Division, with headquarters at Harrisburg, Pa.

Mr. Geo. Jacob Davis, Jr., has resigned his position as Assistant Engineer for the Board of Public Works of Grand Rapids, Mich., to accept a position as Instructor in Civil Engineering at the University of Wisconsin.

Mr. Ernest B. McCready, Assistant Engineer, Department of Inspection of Material, Board of Rapid Transit Railroad Commissioners, City of New York, has been appointed General Manager of the Lehigh Valley Testing Laboratory.

Mr. H. T. Douglas has been appointed Chief Engineer of the Wheeling & Lake Erie, Wabash-Pittsburg Terminal and West Side Belt Railroads, with headquarters at Pittsburg, Pa., vice Mr. George T. Barnsley, assigned to other duties.

Mr. C. T. Dike has been appointed Resident Engineer of the Pierre, Rapid City & Northwestern Ry., a branch of the Chicago & Northwestern Ry., which is being built from Pierre to Rapid City, S. Dak. His headquarters will be at Pierre, S. Dak.

Mr. A. Bruce Smith has been appointed Manager of Telegraphs of the Grand Trunk Pacific Ry., with office at Montreal. He has been Superintendent of Construction and Maintenance of the Great Northwestern Telegraph Co., at Toronto, Ont.

Mr. Harry H. Hornsby, at one time Chief Inspector of the Department of Electricity of Chicago, Ill., and later Sales Engineer of the Conduit Department of the Sprague Electric Co., has been appointed Sales Manager of that department, to succeed Mr. Alexander Henderson.

Mr. F. E. Baxter has resigned his position as Division Engineer of the Denver & Rio Grande Ry., at Salt Lake City, to accept a position with Deal Bros. & Mendendall, railway contractors, of Springville, Utah, in charge of their construction contract on the Western Pacific Ry.

Mr. Wm. Cox, Consulting Engineer, well known to the profession as the designer of a number of ingenious computing instruments or circular slide rules for solving various special problems in engineering, has removed his office from 25 Broad St., New York City, to 75 Broad St.

Mr. B. T. Thomas has resigned his position as Engineer and Superintendent of Dam 37, Ohio River, for the Sheridan-Kirk Contract Co., and has accepted a position as Principal Assistant Engineer to Major J. G. Warren, Corps of Engineers, U. S. Army, 415 Custom House, Cincinnati, O.

Mr. C. M. Ingersoll, Jr., M. Am. Soc. C. E., Chief Engineer of the New York, New Haven & Hartford R. R., has been appointed Commissioner in charge of the new Department of Real Estate, Right of Way and Taxes. Mr. Edward Gagel, Principal Assistant Engineer, succeeds Mr. Ingersoll as Chief Engineer.

Mr. George Van Keuren, General Superintendent of the Erie Division of the Erie R. R., will retire from railroad service on Nov. 1 to go into the manufacturing business. He will be succeeded by Mr. R. H. Bowron, now General Manager of the Cincinnati, Hamilton & Dayton R. R. Mr. Van Keuren has been connected with the Erie R. R. for 21 years.

Mr. Samuel Parsons, Jr., for some time landscape architect for the Park Board of New York City, has been appointed President of the Park Commission, to succeed the late Commissioner Pallas. It is understood that the appointment is to be a temporary one. Mr. Parsons is vice-President of the American Society of Landscape Architects, and for 15 years was Superintendent of Parks in New York City.

Mr. T. K. Wells has been appointed Superintendent of Transportation for the Manila Electric Railway & Lighting Co., of Manila, P. I., which is controlled and operated by J. G. White & Co., of New York. Mr. Wells has had a wide experience in railroad work, having been with the Wabash R. R. and the St. Louis, Iron Mountain & Southern R. R. for 14 years and with the Syracuse Rapid Transit Co. for eight years.

Col. Thomas H. Handbury, Corps of Engineers, U. S. Army, recently stationed at San Francisco in charge of fortifications and river and harbor works on the Pacific Coast, has been placed on the retired list of the army on account of age by operation of law. Colonel Handbury is a native of Pennsylvania and was graduated from the military academy in the class of 1865. He was first appointed Second Lieutenant of the Second Artillery, and in May, 1866, he was transferred to the Corps of Engineers, to which he has been attached ever since. He reached the grade of Colonel in February last.

Mr. Philip P. Barton, M. Am. Inst. E. E., has been appointed General Manager of the business and operations of the Niagara Falls Power Co., at Niagara Falls, N. Y. The appointment also includes that of General Manager of the Niagara Junction Ry. Co. and of the Niagara Development Co. Mr. Barton was graduated from Cornell University in 1886 with the degree of Ph. B. After two years of post-graduate work in electrical engineering, he received from the same institution the degree of M. S. His professional career was begun in the Electrical Department of the Cambria Iron Co., at Johnstown, Pa. After several months of practical experience there and with the Allegheny County Light Co., of Pittsburg, Pa., he entered the engineering force of the Westinghouse Electric & Manufacturing Co. For some years he was engaged in installing electric lighting and power plants in various parts of the country, mainly in the South and the West. In 1892 he entered the service of the Brush Electric Co., of Cleveland, O., in charge of engineering and sales at its Pittsburg office. After the closing of that office in February, 1898, he was connected for some months with the Pittsburg office of the General Electric Co. In September, 1898, he became Assistant Superintendent of the Niagara Falls Power Co., at Niagara Falls, and two years later was made Superintendent of the Operating Department of the same company. In July, 1905, he was appointed Superintendent of Operation of the Niagara Falls Power Co. and of the Canadian-Niagara Power Co., which positions he has held until his present appointment.

Obituary.

Stephen F. Gale, of Chicago, Ill., who was at one time President of the Chicago, Burlington & Quincy R. R., died Oct. 17, aged 93.

Frederick Grinnell, for many years President of the General Fire Extinguisher Co., of Providence, and well known as an inventor, died Oct. 21 at his home in New Bedford, Mass. For a number of years he [illegible] engaged in the construction of locomotives. He was [illegible] rs old.

Edward R. McNeill, Division Engineer [illegible] Grand Trunk Pacific Ry., died Oct. 7 of typhoid [illegible] at the "Drinkwater" Hospital, Winnipeg. Mr. [illegible] was born on a farm near Garden Grove, Ia., [illegible] 1899, and attended the University of Iowa from [illegible] to 1887. He commenced his railway career with the [illegible] Island R. R. in June, 1887, leaving that railroad [illegible] ber of the following year to take a position as Le[illegible] for the Missouri River Commission. From June, [illegible] to November, 1890, he was Instrumentman for t[illegible] rthern Pacific Ry. in Montana. From the latter [illegible] until 1894 he was in charge of the masonry [illegible] of the Wicks Tunnel, as Assistant Engineer. Th[illegible] t five years were spent in private practice. In [illegible] he returned to railroad work, as Engineer in Char[illegible] of Construction on the Montana Central Ry. At th[illegible] lose of this work, in 1901, he was appointed Resident [illegible] gineer in charge of maintenance and construction on [illegible] Middle District of the Great Northern Ry., which [illegible] on he resigned in September, 1903, to become a Dist[illegible] t Engineer of the Grand Trunk Pacific Ry., at [illegible] monton, Alberta. A temporary cessation of the work, [illegible] August, 1904, caused him to move to Vancouver, as [illegible] Engineer of the Vancouver, Western & Yukon [illegible] Ry. In April, 1905, he returned to Edmonton, as Distr[illegible] t Engineer, and on July 1 he was promoted to the Winnipeg office as Division Engineer, in charge of 500 miles of location and construction. This position he held until his death. He leaves a widow and one son, aged 7 years.

ENGINEERING SOCIETIES.

COMING MEETINGS.

MAINTENANCE OF WAY MASTER PAINTERS' ASSOCIATION.
Nov. 13, 14. Annual meeting at Cincinnati, O. Secy., H. J. Schnell, 100 William St., New York, N. Y.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 16, 17. Annual general meeting at New York, N. Y. Secy., Wm. J. Baxter, 12 West 31st St., New York, N. Y.

AMERICAN MINING CONGRESS.
Nov. 14 to 18. Congress at El Paso, Tex. Secy., J. F. Callbreath, Jr., Denver, Colo.

ASSOCIATION OF TRANSPORTATION AND CAR ACCOUNTING OFFICERS.
Nov. 21. Annual convention at St. Louis, Mo. Secy., G. P. Conard, 24 Park Place, New York, N. Y.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 4 and 5. Annual meeting at New York, N. Y. Secy., W. H. Ross, 258 Broadway, New York, N. Y.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 5-8. Annual meeting at New York, N. Y. Secy., F. R. Hutton, 12 West 31st St., New York.

UNION OF MANITOBA MUNICIPALITIES.—The annual convention will be held at Brandon, Manitoba, on Nov. 23 and 24. A number of papers are to be read, and there will be an address by Mr. Lighthall, of the Union of Canadian Municipalities. The local arrangements are in the hands of the Mayor of Brandon.

APPALACHIAN ENGINEERING ASSOCIATION.—The next meeting of the Appalachian Engineering Association will be held at the Bluefield Inn, Bluefield, W. Va., on Saturday evening, Nov. 4th, 1905, at 8.30 p. m. Papers will be read on "The Sixth Sense of Engineering," by Mr. H. C. Rowie; "The Use of the Slide Rule," by Mr. C. C. Wentworth; "The Growth of the Tug River Coal Field, 1900-1905," by Henry M. Payne and others. Secy., H. M. Rayne, Williamson, W. Va.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.—The program of the coming annual meeting, to be held at 12 West 31st St., New York, N. Y., on Nov. 16 and 17, comprises the following papers: "Some Problems in Ferry-boat Propulsion," by Mr. E. A. Stevens; "Experiments with Ventilating Fans and Pipes," Mr. D. W. Taylor; "Investigations relating to the Action of Screw Propellers," by Prof. Wm. F. Durand; "Some Results of Tests of Model Propellers," by Messrs. A. V. Curtis and L. F. Hewins; "The Cruiser," by Commander Wm. Hovgaard; "A Comparison of Recent Battleships," by Mr. H. G. Gillmor; "The 'Ultima', a Globular Naval Battery," by Mr. A. P. Stokes; "A Tale from Japan," by Mr. G. W. Dickie; "Longitudinal Bending Moments of Certain Lake Steamers," by Mr. W. I. Babcock; "Some Notes on Steam Boiler Troubles," by Mr. H. See; "Notes on the Strength of Water-tight Bulkheads for Battleships and Cruisers," by Mr. H. F. Norton; "Marine Turbine Propulsion," by Mr. C. G. Curtis; "Marine Steam Turbine Developments," by Mr. E. M. Speakman; "How a Ninety-footer Behaves in an Ocean Race," by Mr. P. E. Stevenson; "Problems in connection with High-speed Launches," by Mr. C. H. Crane; "Progressive Speed Trials of the Gasoline Launch 'Ludo', by Mr. G. C. Cook; "Scantling Regulation in Yachting," by Mr. W. P. Stephens.

The first session of the meeting is to be held at 10 a. m., Thursday, Nov. 16, and the meeting will continue through that and the following days. A banquet at 7 p. m., Friday, Nov. 17, closes the meeting.